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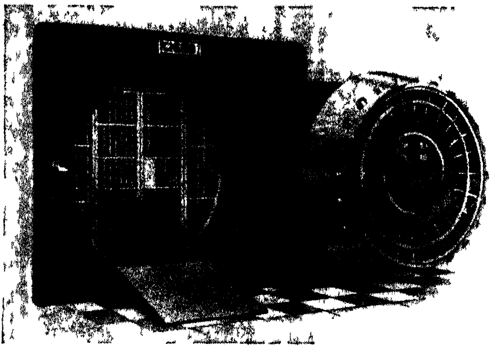

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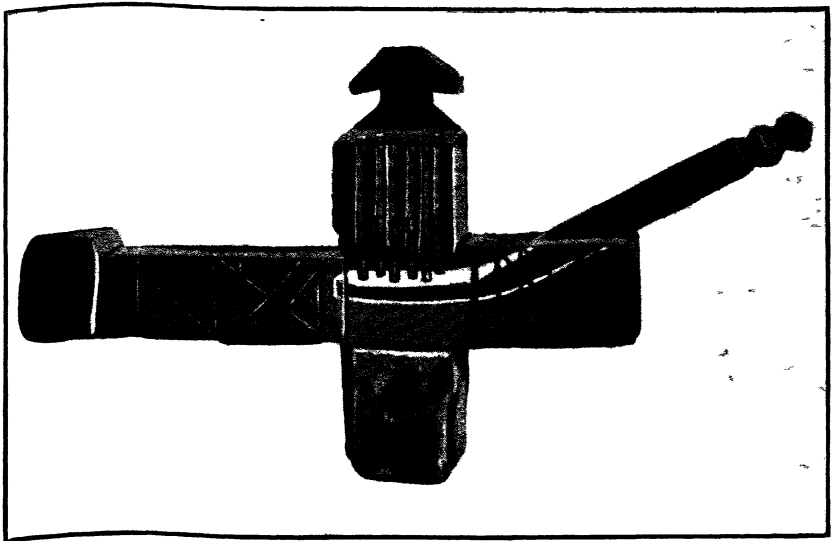

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ANCIENT EGYPTIAN LOCK, MADE OF WOOD, WITH THE KEY INSERTED

Frontispiece

(14681)

PITMAN'S COMMON COMMODITIES
AND INDUSTRIES

LOCKS AND LOCKMAKING

BY
FRANCIS J. BUTTER

WITH A FOREWORD BY
SIR GEORGE HAYTER CHUBB, BART.*

SECOND EDITION

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FOREWORD

THE contest between the safemaker and the burglar has often been likened to that between the battleship and its armament: whenever a more powerful gun or explosive appears, some improvement in armour plate is sought. So, whenever a cracksman discovers a new method of attack, the construction of the safe is altered to meet it. In like manner, to some extent, the art of the locksmith in the direction of security has been developed to keep pace with the skill of the thief.

Lockmaking, like safemaking, is one of those trades which could not thrive in an entirely honest world. The lockmaker, who is on the side of law and order, can imagine a day when his occupation will be gone. Scientists tell us that after so many millions of years the sun will give no more heat; but it will not so befall in our generation, nor is the end of locksmiths' business imminent.

In 1818, one hundred and eight years ago, my grandfather, Charles Chubb, invented his famous lock, thus inaugurating a new mechanical device which protected and still protects much of the world's wealth. As his descendant, I feel it both a pleasure and an honour to commend to the general public this careful and unbiased work on a subject of considerable interest.

GEORGE HAYTER CHUBB.*

12th January, 1926.

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* *Now The Right Hon. Lord Hayter.*

PREFACE
TO THE SECOND EDITION

WITH the exceptions mentioned hereafter, and a few additions, omissions, and alterations of less importance, the text of the first edition has been retained.

For corrections in the section of Chapter III which has reference to Old Testament words and dates, the author is very grateful to the Rev. W. F. Howard, M.A., D.D., and the Rev. Christopher R. North, M.A., who are authorities on Old Testament languages and history at Handsworth College, Birmingham. In the first edition there were mistakes, particularly in the Hebrew words which had been taken from an old book.

The whole of the description of the Keyless Combination Safe Lock in Chapter IX has been re-cast, in the belief that it is now easier to read and clearer to understand.

FRANCIS J. BUTTER.

17 BALFOUR CRESCENT,
WOLVERHAMPTON.
1931

PREFACE

ON the subject with which this volume deals there is a considerable literature in several languages, covering a period of 250 years from 1627, when M. Jousse wrote about the locksmith's art. Since 1879, some half-dozen books by French and German writers have appeared ; but in this country, with the exception of lectures, papers, and articles, there seems to have been only the work on primitive locks and keys by Lieut.-Gen. Pitt-Rivers in 1883.

Mr. John Chubb's paper *On the Construction of Locks and Keys*, read to the Institution of Civil Engineers in 1850; Mr George Price's book *On Locks and Keys*, 1856; the introduction to *Abridgments of Specifications* (1774–1866) *relating to Locks, Latches, etc.*, published at the Patent Office, 1873; and Mr. Harry W. Chubb's paper to the Society of Arts in 1893 have provided much material for the portions herein dealing with old locks and keys. Other works also have been consulted. In a book of this size many interesting facts must of necessity be omitted.

The author gratefully acknowledges his indebtedness to previous writers, as well as to Sir George Hayter Chubb, Bart., Chairman of Chubb & Son's Lock and Safe Co., Ltd., together with the Managing Directors and others connected with that company in whose service for more than thirty years he has learnt what he knows. For the loan of blocks for illustrations, and in some instances for information, thanks are sincerely paid to Col. A. D. Acland; Messrs. Bramah & Co.; James Gibbons, Ltd.; Hobbs, Hart & Co., Ltd.; Joseph Kaye & Sons, Ltd.; Lips Ltd.; Josiah Parkes & Sons, Ltd.; Sargent & Greenleaf, Inc.; John Tann, Ltd.; E. Tonks & Sons, Ltd.; H. & T. Vaughan, Ltd.; Yale & Towne Co.; the officials of the National Union of Lock and Metal Workers; and others.

FRANCIS J. BUTTER.

WOLVERHAMPTON,
1926.

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LOCKS AND LOCKMAKING

CHAPTER I

A PRELIMINARY SURVEY

LOCKS and keys have had a fascination for many people during long ages. They have been used in some form or other almost from the earliest days of mankind until this present time, when there are few persons who have no need for such conveniences. This partly accounts for the widespread interest in them. Another reason is that locks are really little machines, and many folk take a delight in mechanical contrivances with working parts. Again, there is in man an instinctive love of property or an instinctive love of possession. It is seen not only in the adult, but from the first years of life when the child clings tenaciously to the toys which another child wants. As long as this human trait continues, or as long as one man holds and wishes to keep what another desires, so long anything which seems to strengthen his grip and make more assured his possession will receive his earnest attention. Still another reason can be offered. The possession or the charge of a key which will lock up some receptacle gives to the holder a sense of his own importance or power and does something to satisfy another human longing.

One form of fastening, which does not properly belong to the subject of locks and keys but deserves mention, is the use of seals. A seal would be of little effect in a community which had not a moral sense and did not respect or fear law and authority. It has no physical powers of resistance and no mechanism more or less complex to trouble the ill-disposed. A notable instance of the use of seals in far-away days is the Biblical record that Darius and his lords sealed the door of the den of lions in which Daniel was placed. No lock was needed where the King's device had been impressed, and the King alone could undo his work. The survival of sealing to the present day for securing Post Office dispatches and Customs vaults shows that where there is the indicated desire on the part of authority that certain things shall be inviolate, the wish is respected. The use of a personal or corporate device, originally and still employed as a means of identification and of legal power, readily lends itself to this purpose. The intention of the seal of the private individual behind whom is little or no authority is honoured by considerate people as well as by others, who know that a broken seal may be followed by investigations leading to the culprit's disgrace.

A locked door, like a seal, indicates the owner's wish that it shall not be opened until he chooses. This wish also is respected by a right-thinking community. Its general observance may be one of the reasons why locks of little strength and insecure quality are made and used to such a large extent. Those who know how strong and secure locks can be, and are so made, if not numerously, find themselves from time to time wondering whether the public is sufficiently informed upon the matter. This is not to say that locks of various qualities are not required, because they are ; and in very many instances the locks in use, even the cheapest, are of the right grade in those cases. It is true beyond question, however, that many people, trusting to locks which are not good enough for the valuables which they nominally protect, are living in a fool's paradise, or taking grave and unnecessary risks.

Generally speaking, the public does not trouble much about the security of locks. If when turning the key there is a feeling that work is being done, and the bolt can be seen to move out and in, most people are content. There are several reasons for this widespread complacency besides ignorance on the question of security. In many instances, security is not thought of when a lock is used instead of another kind of fastening to keep a door closed, and the key left in the lock serves the purpose of a handle for opening the door. Quite a simple kind of lock will fill that need, and there are many locks on cupboards and wardrobes serving no other end. In other cases, locks are fitted not to resist determined attempts to open them, but merely to prevent pilfering or meddling by those who pass by. Perhaps the chief reason for contentment when there should be none, is that most locks are never put to a security test. If one buys a knife, a watch, or a motor car, it is tested within a few hours of purchase, whether it will cut, keep time, or run well, as the case may be. If a lock is put on a door to keep out thieves and a thief never tries to get in, the owner of the lock does not learn from a test how much or how little security it provides. It is not to be desired that more dishonest attempts to open other people's locks should be made, but if such took place there would almost certainly be a larger demand for locks of greater security. It may be that makers and salesmen are partly to blame for the fact that so many buyers are ignorant about locks, and purchase qualities which often are not good enough for their requirements.

It is a remarkable fact that by a preponderating majority the locks and keys made to-day in various parts of the world to meet the requirements of those who ask for something above the average quality, are constructed on the principle of one or the other of two types which have seen the light for many years. There are certain exceptions of note, to some of which reference will be found farther on ; but nearly all the best locks opened by keys, in use and now being manufactured, are modelled on the Chubb lock invented in 1818, or on the Yale lock of 1848. It is not likely that either kind will bring about the other's extinction. Many manufacturers make both varieties, recognizing that each has certain advantages not possessed by the other. The purpose of this reference is to point out that, in spite of the many years during which both types have done worthy service, when it would not have been surprising if something newer had supplanted them, their position to-day seems as sound as ever.

In locks operated by keys, no better way of providing security has been found than of employing a number of pieces—the larger the number, the greater the security, other things being equal—which must be moved by the key to certain definite positions before the lock can be opened. These movable pieces, which here for convenience may be called detainers, in different types of locks take different forms. They may be pivoted plates, sliding plates, rotating discs, sliding pins, or something else. To say that one style of detainer is superior to the others would be unwise, since circumstances and method of application affect the case so much. On the contrary, it might be possible to show that the type of detainer does not matter at all, and that one kind will give as much security as another, if there are no conditions to prevent its best application. Be that as it may, the fact remains that although numerous inventions since the middle of the last century have been put forward in which the detainers have taken a form different from both levers and pin tumblers, the newer ideas have not displaced the old. Some of the new ideas have not been without considerable merit, but there has not been found in them the superiority in security, adaptability, or cost, which a new principle of construction must possess before it will depose another, well tried and approved.

During the early part and middle of the nineteenth century, various lockmakers threw out challenges with regard to their own particular locks, and offered considerable rewards to any who could pick them. Of those who made attempts, some failed and others succeeded. Success in several cases was obtained only after many hours or days of patient trial under the best possible conditions. The men themselves were experts ; they had all the tools they needed ; they had unlimited time ; they had previously studied and had at hand for reference a lock identical in construction with the one at which they were working. It is probably true to say that no lock will withstand all that, and that at one time or another every kind of lock has been picked when conditions have been so favourable.

When news of the successes at lock-picking became known and the weaknesses of the several locks were revealed, not only did the makers set about improving their own products, but a host of new inventions came out. Of all the different contrivances introduced then or afterwards for the purpose of increasing the security of locks, few have stood the test of time ; and the Chubb and the Yale types hold the field. Those skilled in lock construction seem no longer to be seeking for new principles, as if they knew the search was vain. The professional's inventive gifts are directed more towards simplification and reduction of cost ; not to devising novel movements, but to obtaining the familiar and approved results by readier means.

The amateurs have a large number of inventions to their names. Some of these are very ingenious. One has seen from time to time their well-thought-out designs and carefully-constructed models, for which all machining processes have been planned and tabulated by their engineer-inventors. Very few, however, are worth serious consideration by the lock manufacturer, although there may be novelty as well as ingenuity in the construction. For the most part, the amateurs' inventions suffer from one or more of three defects. They lack the elements of security, or they embody movements long ago discarded and superseded, or they reach an end by a circuitous route instead of the short cut which the experienced man takes.

Although it has been admitted that locks providing very little security have their place and purpose, security must always be a first consideration in the study of locks, as there is regularly a demand for it. Nevertheless, it is not a universal security which the maker of the lock can give, however well he does ; it is rather a one-direction security. The safemaker is sometimes asked to provide security not only against all the arts, appliances, and forces which thieves and mobs can bring to bear, but against water, fire, fall, and earthquake. The whole of the safe, body and door, as well as fastenings, should withstand attack. The lockmaker, as distinct from the safemaker, has no responsibility beyond the lock itself. Although he may be expected to supply a substantial article which will give security against picklocks, and prevent all keys but the right one from being effective, the fixing of the lock to the door, and the door itself, may be the weak links in the chain of defence which the owner sets up.

In locks to be opened by a key, there have been and are only two methods, broadly speaking, of resisting attempts to open them by anything but the right key. In the ideal lock, it should be impossible to discover by systematic trial a way of overcoming the obstacles to withdrawing the bolt. In other words, the successful opening of the lock by anything but the right key should depend upon chance, and not upon experience and method. Failing the ideal lock and perfect security, the next best thing is to make the difficulties of opening as great as possible for those not in possession of the key.

One of the two methods of giving security to locks is the use of fixed obstacles, going by the name of wards, designed to prevent instruments other than the proper key from reaching the bolt ; the other method is the provision in the lock of one or more parts which detain the bolt, and must be moved in the right direction and to the right extent before opening is possible. Both methods are sometimes combined in the same lock. More information about these contrivances will be found in the following chapters.

At this point it may be helpful to name some of the locks commonly made, and to follow with a few definitions. House door locks are divided into three groups, according to the manner of fixing: (1) mortise locks, if let into the thickness of the door from the edge ; (2) rim locks, for screwing to one face of the door ; (3) flush locks (more rarely supplied), which are recessed into the door from one side. Each of these may be made as (*a*) dead locks, or those with a single bolt requiring the key for both locking or unlocking ; (*b*) two-bolt locks, for which knobs are used to withdraw the spring latch bolt, while the key acts upon the dead bolt ; (*c*) latches (often called night latches) for front doors, the key being used outside and the knob inside; (*d*) locking latches which act as latches, but can be locked by a turn of the key to make impossible the withdrawal of the bolt by the knob. The keyholes in dead locks are on one or both sides as required; in two-bolt locks, on both sides; in latches, one side; and in locking latches, sometimes one side and sometimes both sides. The locks fitted on furniture are known collectively as cabinet locks, which include the kinds familiar to most people, such as drawer, cupboard, wardrobe, and box locks. Then there are locks for trunks, bags, and attaché cases; and padlocks for a myriad purposes. The kinds less frequently seen comprise hook bolt locks for sliding doors and a smaller variety for desks; locks for safes, safe deposits, prisons, and handcuffs; Post Office requirements; straps, letter bags, and portfolios; railway points and switches; show-cases in museums; filing cabinets and steel furniture.

Bathroom doors are frequently fitted with latches which have knobs on both sides but no key action. A catch or bolt inside gives the necessary security. To lock railway carriage doors a plain square-bitted key is used, the bolt being retained in the locked or unlocked position by the pressure of a strong spring.

Of recent years, inventions in other directions have created a demand for new kinds of locks and old kinds for new purposes. For motor cars there are required not only locks for the doors, but frequently locks for the bonnet, steering column, gate change, spare wheel, tool box, and petrol can. Roadside service boxes for members of certain automobile associations are fitted with locks. Book locks for fixing to a private ledger or diary have been made for many years; and now, for loose-leaf binders, different sorts are needed. Large numbers of padlocks are used for gas and electricity meters where the consumer pays for his supply by dropping in a coin. There are various kinds of locks freed by the insertion of a coin. Locks were fitted on military tanks used in the Great War.

Locks for curious and out-of-the-way purposes have been designed at different times, but not often made. In this group appear locks for corks and stoppers in bottles ; lids on milk cans and for fastening milk cans to house doors ; for locking miners' picks where stored ; for miners' safety lamps, window stays, taps, harness buckles ; for fastening hats and coats on pegs ; for locking umbrellas and sticks in a rack ; for locking umbrellas so that they cannot be opened if taken away ; for securing papers together ; for fastening whips in their holders ; to fasten to the strings of a tennis racket, rendering it unfit for play ; for pressure gauges and ticket punches ; and for internal combustion engines to cut off the flow of explosive mixture.

Locks and keys may be arranged under three distinct systems. They may be made all to differ from each other, as the front door locks of houses should all differ. They may be made in a set under the same key, so that a person need carry only one key to open a number of locks. They may be made so that different persons, each with a different key, may open only certain locks ; while another person in a superior position with another key may open all.

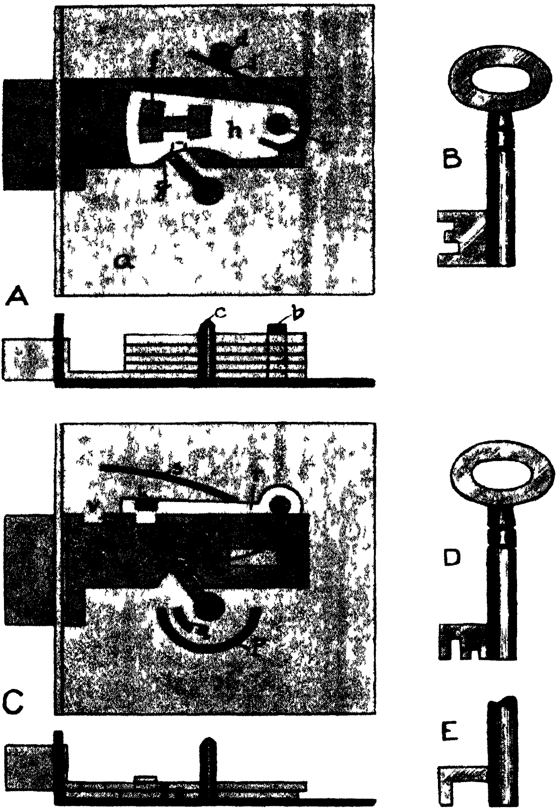
Most of the keys in use are of three kinds: (1) pipe keys, if there is a hole up the stem ; (2) pin keys, if the stem is cylindrical but solid ; or (3) flat keys. That part of a key which enters the lock is the bit, and the handle is the bow. The cuts on the edge of the bit running parallel with the stem are often called steps, other cuts being termed wards. That portion of the key bit which moves the bolt is the bolt step. A key which enters a lock on both sides has a collar above the bit to prevent the key from being pushed right through the lock.

The works of a lock are mounted in the case, but this part is distinctively called a plate if it is flat or has only one side turned up. In the case or plate are fixed the required pillars or stumps. For a pipe key there must be a drillpin, which is the name given to the guide pin on which the key turns. It is hardly necessary to say that the actual fastening member operated by the key is the bolt, the thick part of which is called the head and the remainder the tail or lath. If the bolt is moved both outwards and inwards by the key, it is a dead bolt; if the bolt is drawn in by the key but shoots out automatically, it is a spring bolt. Most bolts slide to and fro guided on a stump within the lock and through a hole in the case or plate. The notch which the key engages in the edge of a bolt is called a talon; its shape varies according to circumstances, and is of importance especially in the dead bolt of a lever lock. The interior of a lock is covered by a cap, which may be flat or otherwise.

The foregoing terms apply to locks of many sorts, and there are others peculiar to the kind of lock. Some of these will be given and explained later.

For the present, look at Fig. 1, illustrating at *A* a four-lever lock with a pipe key *B*; *a* is the plate; *b*, the main stump or lever pivot; *c*, the drillpin; *d*, the spring stump; *e*, the bolt; *f*, the bolt stump fixed in the bolt; *g*, the talon; *h*, the levers; and *j*, the lever springs, to keep the levers in contact with the key and return them to their lowest positions when the key is removed. The cap is not shown. The key has a bolt step at bottom, and four steps to lift the levers. The figure shows the levers partly lifted by the key, which

FIG 1



A	Lock with four levers	*B*	Its key
C	Lock with wards and tumbler	*D*	Its key
E	Skeleton key which will open *C*		

is being turned to draw in the bolt. Further turning of the key will lift all the levers to the position where their gatings, which are the slots running in the direction of the length of the levers, will be in line with the bolt stump. At that point the bolt step of the key will be in the rectangular notch of the talon, and, as turning of the key is continued, the bolt step acting like a single-toothed pinion engaging a rack, will draw in the bolt, during which movement the bolt stump will pass through the gatings of the levers. When the bolt is fully in, the key being farther turned in the same direction will leave the talon and allow the levers to fall under the pressure of the springs until they come to rest on the bolt stump. The curves at the sides of the talon coincide with the path of the end of the bolt step of the key to prevent the movement of the bolt while the levers are falling to rest.

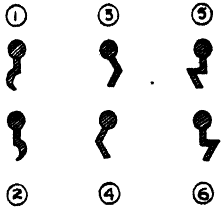
It is easy to understand that if all levers but one are correctly lifted, and that one is raised too little or too much, the gating of that lever will not come into line with the bolt stump, which consequently will be prevented from moving by the bar above or below the gating on that lever. It is in this feature that the security of a lever lock lies, and the principle is the same in other locks having movable detainers, which must take up certain definite positions before opening is possible.

(NOTE. Some people in the trade do not use all the foregoing terms in exactly the same way. The notch in the bolt which the key engages they call the gating, and the piece *f* (Fig. 1) is defined as a talon instead of a bolt stump. It follows that the word gating cannot be applied also to the passage in the levers, so this is frequently described as the lever slot.

As there is good and long-standing precedent for the nomenclature adopted in the text which precedes this note, the author prefers to retain it.)

CHAPTER II

WARDED LOCKS



By courtesy of Messrs. H. & T. Vaughan, Ltd.

FIG. 2

KEY BITS OF FANCY SHAPE

BEFORE dealing directly with warded locks, which constitute the preponderating majority of those in which reliance is placed upon fixed obstacles for security, mention may be made of another kind of fixed obstacle. By this is meant the attempt to exclude improper keys from the lock by the shape and size of the keyhole. Among the ordinary keys on a bunch which a person carries, there are usually several which will not enter a particular keyhole. Therein alone lies no inconsiderable measure of security. A little difference in the size of the stem or bit of ordinary pin and pipe keys will generally do what is wanted. Carrying the idea farther, some keys have bits of fancy shape (as those in Fig. 2), the keyholes of the locks being shaped to correspond. If security against unskilled persons who would attempt to open another's lock with only the keys at their command is all that is required, such devices may serve. Against determined attempts they are not of much use as the sole security, because the keyhole of a lock is often accessible and may be altered in shape or enlarged with a file. Again, where the keyhole is accessible, it is not a difficult matter for a practical man to make a key to fit it, or get his lock-picking instruments at work. It must nevertheless be made clear that if the shape or size of the keyhole does not constitute the sole protection, but is used as an auxiliary measure, it is not to be despised.

It is not known whether warded locks were first made in this country or introduced from abroad. They are mentioned in early manuscripts, and are next in antiquity to the ancient Egyptian locks, albeit inferior in the principle of security to their predecessors.

In locks up to the year 1778 or thereabouts, with very few exceptions as far as knowledge goes, security depended upon wards. A ward is a piece of metal, or a combination of pieces of metal, fixed within the lock in the path of the key. Unless the key is cut or notched to pass over the ward, it cannot fully enter the lock, or, if it enters, it cannot turn. Fig. 1 represents at *C* the interior of a lock with two wards different in height, and *D* is its key. As the outer ward *p*, semicircular in shape, extends across the keyhole, it is obvious that the key requires a slit to pass over this half ring before it can enter the lock the full distance. The inner ward *q* is a small portion of a ring, and is not visible through the keyhole ; but it is enough to prevent the turning of the key, unless the key contains another slit. Both these are simple wards, although simple wards are not usually half rings ; more often they are merely small segments of metal either directly under the keyhole to prevent the entry of the wrong key, or somewhat to the side to prevent its turning.

Many wards are of a complicated form, such as those to match the keys shown at *A* and *B* in Fig. 3. Wards still more intricate were cut in the olden days, and very impressive-looking keys resulted. The making of such wards involves a good deal of careful work ; the separate rings or segments, which often are little short of the complete circle, are bent and filed from sheet metal, after which they are joined together by brazing. If all the members are not concentric curves, trouble is likely to follow. The cutting of the keys to match the more intricate wards in the lock takes time and skill. Only a few of the cuts can be sawn or filed; others, on account of the curvature, have to be chipped with a small chisel.

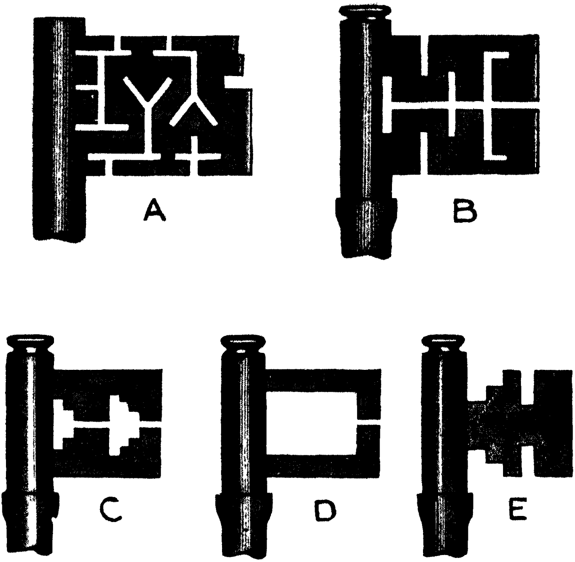


FIG. 3

A, B, C, D, E, WARDED KEYS

In locks which are to open from both sides, it is necessary that the warding of the key should be alike on its two sides. Such wards are divided into three classes: fine wards, solid wards, and sash wards. The fine ward is built up of sheet metal with brazed joints as already described, and a two-side key for a ward of this kind will be seen at *B* in Fig. 3. The solid ward has a similar application, but is made of solid brass to fit the formation of a key like *C* in Fig. 3. The wards for both these keys would be mounted on a plate or bridge to pass through the long central cut in the key bit, and the bridge would be supported on cheeks or pillars fixed in the case of the lock. Sash wards for a key of the style of *E* in Fig. 3 are solid brass lumps riveted in the case of the lock, and then shaped with a cutter as required.

Warded locks of the better qualities, in addition to the wards which provide the security and the bolt which does the actual fastening, generally have a single-acting tumbler. This is seen at *r* in view *C* (Fig. 1), together with the spring *s* bearing upon it. The tumbler is pivoted on a pin fixed in the case, and has on its top edge a projection *t*. The top edge of the bolt *u* is provided with two notches *v*, in one of which the projection on the tumbler engages, whether the bolt is out or in. The tumbler consequently gives a little additional security, for it must be lifted enough to disengage its projection from the notch in the bolt before the bolt can move. The key, just before it comes in contact with the bolt, lifts the tumbler, whose chief function, however, is not to provide security, but to hold the bolt out or in. Were there nothing of this kind, the bolt would be without check and free to slide.

The security of warded locks suffers from two defects in the principle. One is the ease with which an ingenious picker will generally be able to take an impression of the wards, no matter how complicated they may be, on a blank key coated with wax, tallow, or soap. The other defect is that the intricacies of the wards in most cases need not be exactly followed in the key. Provided the cut is large enough to pass over the ward, it does not matter how much too large it is, as long as the key bit holds together. The only part of the bit of a warded key which does actual work is that edge furthest from the stem and parallel with it. This is the part which lifts the tumbler and moves the bolt. Consequently if that extremity remains attached to the stem by a connecting member which the wards do not obstruct, all the rest of the bit may be cut away. Fig. 1 at *E* shows a key so cut away, and this key would open the lock *C* just as well as key *D* would. Another example is key *D* (Fig. 3), which would be as effective in the lock as key *C*, shown on the same page. This kind of key, from which all inoperative metal is removed, is the skeleton key so beloved of the romancers. There are some patterns of wards, it may be said, not many in number, and these complicated and rather frail, which the key must follow properly, for the reason that any variation would involve the separation of the bolt-moving end of the bit from the stem.

The tumbler, whether as an additional member in warded locks, or as the sole security feature as it is frequently found to be in other locks, is an imperfect article. It is true that the tumbler must be lifted high enough for its disengagement from the notch in the bolt before the bolt can move. It is in the fact that any excess lift is no hindrance to unlocking that the fault lies. As long as it is lifted enough, it does not matter how much it is lifted. For this reason, it is called a single-acting tumbler, a device which was fitted certainly as far back as the time of Queen Elizabeth.

When a single-acting tumbler is not fitted, the bolt is usually provided with a check spring, often called a back spring, which holds it in both the locked and unlocked positions, so that it shall not move under vibration or by gravity. Sometimes a piece of metal is bent to form a combined bolt and check spring, and certain common locks contain nothing else. It will be understood that the cheaper locks may be fitted internally with any of the following arrangements: (1) back spring only; (2) back spring and ward; (3) single-acting tumbler only; (4) single-acting tumbler and ward. The warded locks may have a single ward or more than one. In locks without wards, the key is sometimes cut as if wards existed, and the owner may think his lock is better than it actually is.

Thousands of simple warded locks are made annually, the whole of which are only duplicates of those which have been made every year for generations past. Locks with complicated fine wards are rarely made now, as more security at less cost can be given in a lever lock.

CHAPTER III

OLD LOCKS AND KEYS

OLD locks and their keys together form a subject which has received considerable attention. The earliest types, although crude, ungainly, and inartistic, demand notice for the admirable means adopted by their makers to provide the security. After these, through another and a longer period, appeared locks which, according to present ideas, were inferior in respect of security to the primitive forms. On the other hand, many of these locks of the second period were so beautifully fashioned that the work of the artist overlaid and sometimes obscured the mechanical intention. This is true no less of Roman times than when French and German smiths of the Middle Ages encrusted their lock plates with Gothic mouldings and carved their delicately shaped keybows. As the styles of architecture and its kindred arts succeeded one another, the decoration and treatment of locks and keys were affected by the same changes. Mechanically they altered also, if not always for the better. During the period in question, it cannot be said that progress in mechanical invention was equal to progress in art. It was a later age which showed itself more utilitarian than artistic, and in it the mechanical features of locks were of greater significance than their appearance.

It is quite reasonable to suppose that the first barring of a door was done by means of a cross beam, either dropping into sockets or sliding in staples fixed in the door; and it is equally reasonable to suppose that if it slid, a vertical pin entering a hole which passed through both beam and staple, kept the beam in place.

If the beam was inside the door and the pin had to be released before the beam could be moved, a certain kind of key was necessary for use outside, although the pin might be visible and accessible from the inside. If the beam was on the outside, the locking must be hidden and only reached through a hole in the beam, or else through a hole in the staple. The Egyptians adopted the former method ; other primitive peoples adopted the latter. The Egyptians shortened the beam into a long bolt and made it hollow for part of its length, so as to reach the pin hidden in the beam and staple through the beam itself. The key, which was pushed up the hollow, had pegs on it to match the pins which held the bolt, the one pin now being multiplied. When the key was fully in, it was raised, and so its pegs lifted the pins out of the way, leaving the bolt free. Then the bolt was drawn back by the key, the pegs of the latter filling up and engaging with the holes which, until then, were filled by the pins. The frontispiece to this book illustrates an Egyptian lock with the key inserted.

There was another class of primitive locks, those in which the pins were reached through a hole in the staple and not through the bolt. There is good reason to believe that they were once remarkably widespread, although now chiefly found on the fringes of culture. They may be seen at the present day in some parts of Scandinavia, in the Hebrides and Faroe Islands, and the peasant of Normandy still makes them for his gates and barns. They have also been observed upon the West Coast of Africa ; and Herr Andreas Dillinger, of Vienna, whose name is known in Germany in connection with the historical study of locks, states they are in use in the less frequented parts of Galicia, Rumania, and Serbia. The hole in the staple by which to get at the pins is a horizontal one above the bolt. The pins are square in section, and are notched on their sides for the key to pass and get into position before being lifted. The key is usually flattish, with little side projections which engage the pins. After they are lifted, it is necessary to pull back the bolt by hand, thus making a marked and essential difference between this lock and that of Egypt, in which the bolt is withdrawn by the key itself. They vary in detail, some having two sets of pins, the key passing between the sets ; in others, the pins have holes right through them for the key, not merely side notches.

The next two classes of primitive locks are those in which the beam or bolt was mounted on the inside surface of the door. In this case, if fastened by the tumbler pin, it would not be necessary to conceal it as when both were outside the door. There are some curious sickle-shaped pieces of iron found now and again, which look as if they were made for the purpose of putting through a hole in the door and pulling up or pushing up the pin. Perhaps they simply engaged the bolt in a direct fashion, and, being turned from the outside, moved it to and fro. But they vary in their outlines too much for this supposition to be probable, some being full sickle-shaped and others only slightly cranked or bent, and in some well-preserved specimens their ends have been carefully shaped as if to fit a hole exactly. They have been found at many places in France and Germany. General Pitt-Rivers, who has so clearly traced the early growth and sequence of lock mechanism, well authenticates some he himself found, near Lewes, as belonging to the late Celtic period.

In the fourth primitive type of lock, the bolt or beam was still inside the door. In this type the bolt was kept in the fastened position by the projection of a spring or springs, which spread out against the sides of the staple. The first function of the key was to compress the springs. The key was somewhat flat in form, with prongs or hooks on the end. It was first passed through an horizontal slit in the door and bolt, then turned a quarter circle, and pulled. The pull caused the prongs to bear upon the springs of the bolt, making them lie flat and so clear of the fixed obstructions at their ends. The bolt was then free to slide back, this being effected by simply sliding back the key, which had its prongs embedded in the bolt. The keys of these locks are numerously found among Roman remains, and locks of this kind are stated to be in use still in Norway.

The frequent mention of locks and keys in the Old Testament, as well as in the works of ancient classical writers and commentators, clearly shows their great antiquity. In the Book of Judges (Chap. iii), it is recorded that after Ehud had stabbed Eglon, King of Moab, he " shut the doors of the parlour upon him, and locked them," and when the servants came and found the doors locked, " they took a key, and opened them." This would probably be in the twelfth or thirteenth century B.C., and there is no reason to doubt that by that time locks and keys were in use in Palestine. In the Song of Songs (Chap. v, v. 5) there is a poetical reference to hands dropping myrrh on "the handles of the lock." Then in the book of Nehemiah (Chap. iii, v. 6), 445 B.C., it is stated that at the time of repairing the old gate of Jerusalem, they " set up the doors thereof, and the locks thereof, and the bars thereof." In confirmation of other records that keys in the early days were very large, there is in the prophecy of Isaiah (Chap. xxii, v. 22), *circa* 712 B.C., this passage: " And the key of the house of David will I lay upon his shoulder."

In describing the most ancient lock ever discovered, which once secured the gate of an apartment in one of the palaces of Khorsabad, Mr. Bonomi writes: "At the end of the chamber, just behind the first bulls, was formerly a strong gate of one leaf, which was fastened by a large wooden lock, like those still in use in the East, of which the key is as much as a man can conveniently carry, and by a bar which moved into a square hole in the wall." It is to a key of this description that the prophet Isaiah probably alludes. Some of the Egyptian keys were over 2 ft. long.

The word סָגַר (*sagar*, to close in), used in Genesis (Chap. xix, v. 6), is the root of the word מַסְגֵּר (*masger*), rendered "smith" in our translation (Jer. Chap. xxiv, v. 1), and "locksmith" by Buxtorf.

The word for key מַפְתֵּחַ (*maphteach*) occurs in the passages in Judges and Isaiah already mentioned, and is the word still in use all over the East at the present time.

The invention of locks may be justly ascribed to the ingenuity of the Ancient Egyptians. We learn that 2,000 years before the Christan era, when Pharaohs held their Court at Thebes, attended by princes and the insignia of royalty, and when magnificent temples were created for their false gods, the offerings of ivory and cedar, the gold of Ophir, and the spices of Arabia were presented and deposited in securely fastened rooms.

A sculptured representation of the locks of that time has been discovered amongst the *basso-rilievo* adornments of the Great Temple of Karnac, and shows that during a period of 4,000 years no appreciable alteration in the construction of Egyptian locks has taken place. In his *Survey of the Turkish Empire*, published in 1798, Eton describes this kind of lock; but it was not generally known in Western Europe until the French invasion of Egypt at the beginning of the last century, when further particulars of it and an engraving were given by Denon in his great work on that country. He describes the lock as "simple in construction, easily made, as secure as other locks, and serviceable for all rustic purposes." It has been discovered that at Thebes the Egyptians sealed these locks with clay.

There is related by Mr. J. F. Jones, B.A., in his account of his travels in Upper Egypt, an incident which occurred during a visit to an old temple built by the Cæsars at Esneh, on the Lybian side of the Nile, about a day's journey from Thebes. He says: "We were at the portico by seven in the morning, and instead of being allowed to walk in as usual, we found it closed against us, the place being now a Government granary. We insisted upon the door being opened, though it was some time before we could get in; no one would go for the key or say where it was; then someone said it was lost, so as to have some claim upon us for 'backsheesh.' However, it turned up at last, and a wonderful affair it was—a long wooden bar with some pegs at one end, which conferred upon it the mysterious power of opening the Pasha's big door."

Aratus, in order to give his readers an idea of the form of the constellation of Cassiopeia, compares it with a key; and Huetius states that the constellation answers to such a description, the stars to the north composing the curved part, and those to the south the handle.

There is some curious information on this subject in Parkhurst's *Hebrew Lexicon.* "In the early ages," he observes, "they made use of certain crooked keys, having an ivory or wooden handle. These keys were placed in the holes of doors, and by turning them one way or the other the bolt was moved forward or backward in order to open or shut the door." Homer confirms this (*Odyssey* xxi) where he says that Penelope, wishing to open a wardrobe, took a brass key, very crooked, hafted with ivory. Pope's translation of this passage runs—

> A brazen key she held, the handle turn'd,
> With steel and polish'd elephant adorn'd;
>
> * * * * *
>
> The bolt, obedient to the silken string,
> Forsakes the staple as she pulls the ring;
> The wards respondent to the key turn round;
> The bars fall back; the flying valves resound;
> Loud as a bull makes hill and valley ring,
> So roar'd the lock when it released the spring.

Eustathius remarks that this kind of key was very ancient, and differed from the keys having several wards, which have been invented since, but that those ancient keys were still in use in his time. The poet Ariston, in the *Anthologia* (Book VII), gives a key the epithet, *βαθυκαμπής*, i.e. "one that is much bent." These crooked keys were in the shape of a sickle (*δρεπανοειδής*) according to Eustathius; but such keys not being easily carried in the hand, on account of their inconvenient form, they were carried on the shoulder, as we see our reapers carry on their shoulders, at this day, their sickles joined and tied together. Callimachus, in his hymn to Ceres, says that the Goddess having assumed the form of Nicippe, her priestess carried a key (*κατωμαδίαν*), that is, *superhumeralem*, "fit to be borne on the shoulder."

Pliny is one of those who attribute the invention of keys to Theodorus of Samos; but this is discredited by other authors, who mention them as having been in use before the Siege of Troy.

According to Propertius, and Eustathius's commentary on the *Odyssey*, the earliest locks were not fixed, but removable after the manner of our padlocks, and were linked to chains and staples affixed to the door post. Eustathius also, in his notes on the tenth Book, attributes the invention of keys to the Lacedemonians, the lock subsequently invented by that ancient people and styled the " Lacedemonian " being much celebrated by early writers. This lock was especially adapted to inner doors, and in process of time it was improved by the insertion of the bolt in an iron frame or rim, permanently attached to the door by a chain, and fastening the door by the insertion of the hasp, through the eye of which the bolt was forced by the application of the key. Montfaucon says the doors of the ancients had many bolts moved by chains, secured by a chain-lock.

A great many of the keys of olden times have been found at different periods ; most of them are of bronze, but some are made of iron ; many of these keys have numerous wards peculiarly shaped, extending considerably up the shank and belonging without doubt to warded locks, which, judging from the intricate arrangement of the ward-bits of their keys, must have been elaborately contrived. Lipsius, in his comments on the second book of Tacitus, is the first to allude to the ancient usages respecting keys, which in some cases he states to have had a ring adapted in size for the purpose of being worn on the little finger, and engraved to answer the purpose of a seal ; and Garlaeus, in his *Dactyliotheca* (42nd section), gives an example of a key, the wards of which are similar to modern keys ; and suitably mounted on the ring, which was adapted to the finger, was an onyx engraved with the helm of a vessel between two ears of corn, typical probably of the occupation of the wearer. From the evidence of various early writers it seems safe to conclude that the Greeks and Romans learned the use and construction of locks and keys from the Egyptians.

To the Chinese is ascribed the invention of another ancient lock having movable wards or tumblers. In an old Chinese book, this lock is described as having sliders and tumblers of different lengths. It was originally constructed of wood, and for many centuries has been extensively used throughout the Celestial empire.

Keys found at Herculaneum and Pompeii, some being attached to rings, prove that a kind of warded lock must have been well known. Traces of a lock still remain there on the marble door of a tomb. In the year 1689, during the progress of some excavations on the plain at the foot of Vesuvius, on the spot which subsequently proved to be the site of Pompeii, a workman observed the regularity with which the successive layers of earth and volcanic matter were deposited. Under one of these masses of scoria, dust, and pumice-stone he found a quantity of timber, locks, and iron-work, evidently the remains of ancient habitations, which, together with a number of old keys, and inscriptions giving the name of the locality, assisted to satisfy the antiquarian of the day that this discovery fixed the locality of the ancient city.

Roman keys have been found also in various parts of England, and specimens are to be seen in the British Museum, some being rigidly attached to finger rings. Mr. Price declares that the holes and cuts in the keys discovered at Herculaneum and Pompeii, of which three are illustrated by Fig. 4, are distinct from the old Roman keys found in this country, and indicate that they did not perform a complete revolution in the locks, which, in consequence, were the equivalent of the spring locks of modern days. Roman keys are found much more frequently than Roman locks, some being of such shapes that it is not always easy to say what their locks were like. One kind of key has its bit angle shape; one angle is cut to operate bolt pins in the way already described, the other being pierced with holes as if to pass fixed obstructions or wards. Many of the keys were undoubtedly made to turn, their stems being pin or pipe, after the manner of modern keys. Some of the pipes were drilled right up so that any dirt or other obstructions could be pushed through. This old idea is from time to time brought forward as a novelty by one or another in these days.

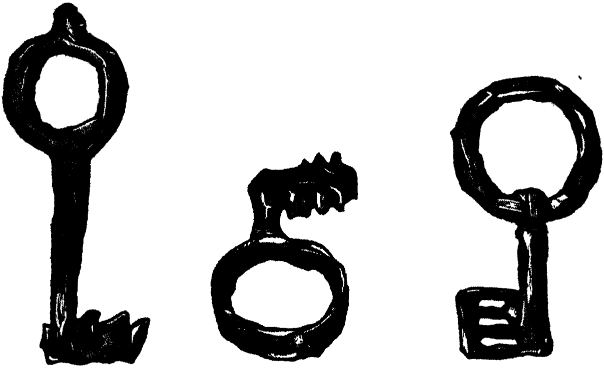


FIG 4

THREE ROMAN KEYS FOUND AT HERCULANEUM AND POMPEII

Roman padlocks in metal were constructed very much after the fashion of the fourth primitive type of wooden lock for doors mentioned earlier in this chapter. The shackle or hasp, which was separate from the body, carried on its lower side a pair of spreading springs, which entered a hole in the end of the body when the two pieces were being put together. When the hasp was pressed in fully, the springs, which during the operation had been gradually closed up, spread out inside the body and so held the two pieces together. To take them apart, the springs, which were simply flexible barbs, had to be compressed. This was done by the key, which was pushed through a hole in the body against their sides near the point and then slid along them. This style of padlock, sometimes with more than two springs, is found to be the almost universal native type in China at this day, so one wonders who was the first and true inventor, Roman or Celestial. Being a loose portable lock of a kind convenient to secure baggage of all sorts in transit, it might easily become well known, especially along the ancient trade routes. These padlocks, whether Roman or Chinese in origin, are seen all over the East, shaped and decorated in ways peculiar to their own countries. Some are shaped like dragons, others like horses or dogs, the tails forming the hasps. In the Indian Museum there is a padlock with diverging springs like those just described, but to close the springs of this lock the key is not merely pushed, but has to be turned like the key of an ordinary padlock at the present day. Many mediaeval padlocks, especially French, were made like this. The Romans had other kinds of padlocks as well, in which the security parts were made like those of their fixed locks. The padlock has always been in favour as a fastening with the Greeks and Romans, and the natives of the East. In all probability the movable lock succeeded the primitive. It seems to form the connecting link between the earliest locks and those of more recent date.

Many archaeological discoveries indicate what the Roman fixed locks were like, but none so clearly as those unearthed at Pompeii. From specimens in the Naples Museum, the similarity is seen between the Roman locks and the Egyptian. The bolt is much shortened and is concealed behind a front plate ; it is still held, when locked out, by vertical pins falling down into it. The parts are mostly, if not all, of metal, sometimes in a wooden casing or block. The pins vary in sectional shapes, being oblong, square, and triangular, as well as round, and are pressed down by a flat spring. The key has projections or teeth formed on it corresponding to the pins, and reaches the bolt through a hole in the front plate. The pins being pressed up by the key projections, the bolt is free, and can slide to and fro precisely as in the Egyptian lock.

There is an absence of information about locks and keys in the Byzantine period. Garnett says: " The empire preserved much, but did not add to the treasures of civilization."

According to a writer in 1850, locks identical in their construction with the Egyptian, or so closely resembling them that it would not be easy to distinguish one from the other, have been in use in Cornwall from time immemorial. These might have been introduced by the Phoenicians, who, by so doing, laid the foundations of this particular industry in this country.

The Celtic nations used locks of wood. An old lock of this description is preserved in the Museum of Antiquaries in Edinburgh. Fosbroke says that wooden locks are common in the Highlands of Scotland, artfully contrived with wooden notches, which can only be opened by the wooden keys that belong to them.

As early as the twelfth century, English-made locks were tolerably secure and considerably ornamented ; but no reliable information exists as to the period when the manufacture commenced, although it is conjectured that rough specimens were produced by the British artisans before the time of Alfred. From the fourteenth to the end of the sixteenth century, great advances were made in the constructional details and finish of locks, the wards became more complicated, and the manufacture partook somewhat of the excellence displayed by the smiths and workers in iron and steel, who then acquired such well-deserved renown in the production of swords, shields, and other military equipment. A specimen lock of the fourteenth century may still be seen in the parish of Snodland, Kent ; and in Winchester Cathedral there is a metal lock mounted with brass ornaments and very massive. An entry in the books of accounts of the Manor of Savoy, published during the reign of Richard I, records the purchases of " two stock lokkes, price xxd., and two hange lokkes (padlocks), price xvjd." The "Durham booke," bearing date 1531, contains a locksmiths bill for two stocklocks at ivd. each, and three padlocks at iid. each.

With the commencement of the Mediaeval period, we get to shapes of keys more like our own, and working more like them than the preceding types. The sliding and pushing have given place entirely to turning movements, the keys being either made pipe-fashion, to slide on to a fixed pin in the lock, or else made solid, and terminating in the projecting pin, which fitted a socket or hole cut in the back plate of the lock. The early mediaeval keys have their humble bows in symbolical, or, speaking generally, in ecclesiastical shapes—trefoils, quatrefoils, and the like. Most of those remaining to us are of bronze.

At this period appeared the forerunner, in direct and unbroken line, of the ordinary tumbler lock of to-day. It had a bolt provided with a talon, and was held in place by a tumbler. The tumbler, instead of moving vertically like the pins of older locks, was hinged. The word " catch " describes it better than tumbler. A part of it came down over the bolt to reach the key, and the first thing the key did when turned was to lift the catch ; then as the user went on turning, the key caught the bolt in its talon and moved it. Besides these thirteenth century locks with the single tumbler, those with fixed wards were in use, their keys showing numerous and intricate slits and perforations to pass over and around them. Warded locks appear to have been the chief kind used for many centuries. Among the primitive we found four types ; at this stage we have but two—the letter padlock does not come until the commencement of the seventeenth century.

Very beautiful specimens of keys were fashioned in the fifteenth and early sixteenth centuries. Two sixteenth-century keys are shown in Fig. 5. A few good examples are to be seen in the South Kensington Museum and some in the Musée Cluny. For perfect proportion in all their details and minute workmanship, they have never been excelled even by the later Renaissance keys. In the same period were produced the highly ornamented lock plates of French and Flemish make. The mouldings of the traceries upon the French locks were made of layer upon layer of saw-pierced plates, one plate on top of another, their edges forming the members of the miniature mouldings. Where there were no figures or other devices, to which the traceries were only secondary, there was sometimes a background of brass, giving a contrast in colour.

The German workers of this period excelled more, from the artistic point of view, in the decoration of their lock plates than in fine keys. To begin with, the outlines of the plates are more fanciful. The surface decoration of the plates consists of a single thickness of metal, cut out and embossed often to represent conventional flowers and fruit growing on stems that branch out

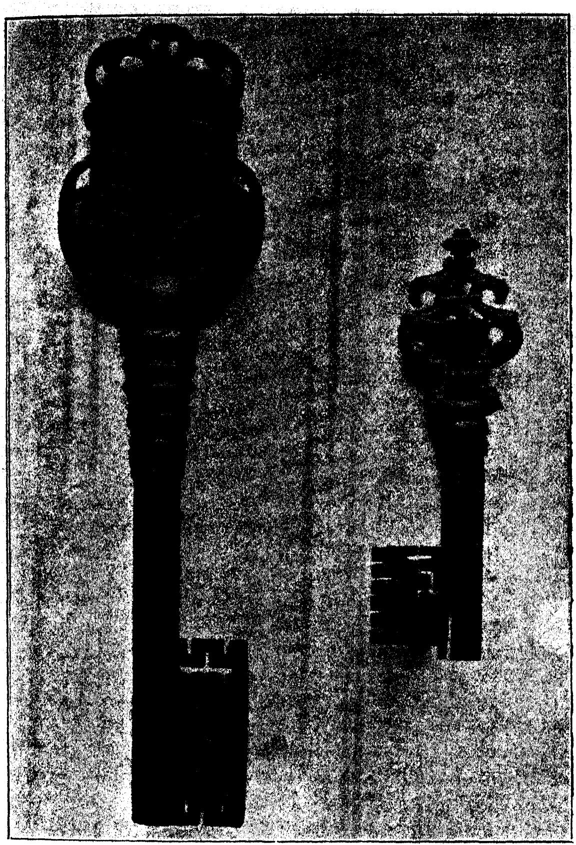
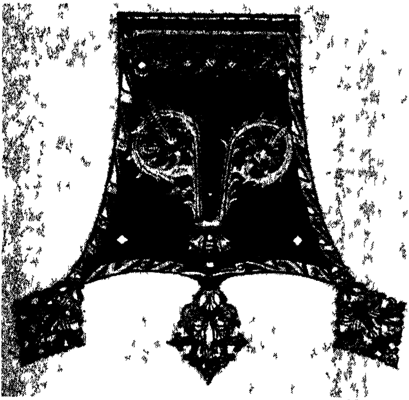


FIG. 5

TWO SIXTEENTH-CENTURY KEYS

The larger, 9 in. long, has its bow pierced with scrolls. The smaller, 5 in. long, has a bow in the form of two winged monsters, back to back gracefully from below the keyhole The converging branches thus form guides by which to find the keyhole on a dark night, or when, from other causes, it was a difficulty to hit upon it. (Wyatt) Recently, the idea of external projecting guides to a keyhole was patented in England There is an interesting thing about these German lock plates that partly accounts for their shape. Their bolts were generally shot out by springs and, to get long—though not always easy-working—springs to act upon them, the end of the plate was made much wider, in order to hold and cover them. Hence there is a direct result of form springing from utility. The same form is common to many Japanese locks, if not owing to the same cause Fig. 6 of a

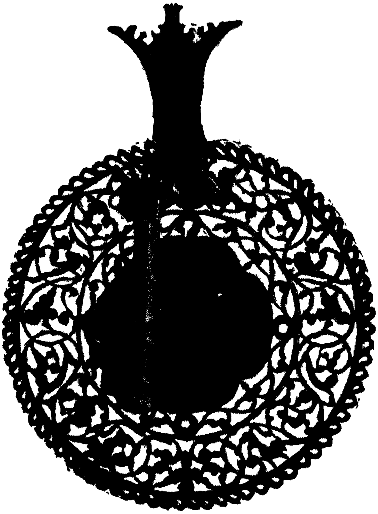


By courtesy of *Messrs Chubb & Son, Ltd*

FIG 6

SPLAYED LOCK PLATE FOR A CHEST
(German)

German lock plate at Augsburg Museum is in this style ; and Fig. 7, of a different shape, illustrates a sixteenth-century plate, about 9 in. diameter, in the Birmingham Museum.



By courtesy of Messrs. Chubb & Son, Ltd.

FIG. 7

CIRCULAR LOCK PLATE, ABOUT 9 IN. DIAMETER, WITH PART OF HASP
(Sixteenth century)

Renaissance work pure and simple now claims attention, and there are some very pronounced specimens, as regards keys especially. A locksmith named Mathurin Jousse published a book on his trade at Paris in 1627. He discourses on the behaviour of apprentices to their masters, and of their treatment by their masters; tells how he prepares his metal and how he shapes his tools; descants on the shapes of padlocks; gives names to multitudinous keywardings; describes a file-cutting machine; and finishes up with an invalid's wheeling-chair, and artificial arms and legs made in sheet iron. The book is fully illustrated. One of his keys resembles the celebrated Strozzi key from Florence, which passed into the possession of Baron Adolphe Rothschild. This is said to have been made by Benvenuto Cellini; but M. Piot, a French writer of authority, doubts the statement. M. Jousse incidentally says that ordinary padlocks with spherical bodies were easy to make; but when they had two hasps, and a key going in each side to secure each hasp, they were difficult. In this period the section of the stem of pipe keys was not always circular; sometimes it was triangular or trefoil in shape, and the drillpin was shaped to suit. Then the drillpin was made to turn with the key. The outside of the key was often fluted.

There is in the possession of Col. A. D. Acland, of Welwyn, an interesting lock similar in style to three or four of French make now at the Victoria and Albert Museum, but larger and in better condition. This lock, illustrated by Fig. 8, is seventeenth century, and came from the Shandon collection. It is of bright steel, measuring 9 in. long, and is said to be an apprentice lock, that is, a lock made by one who, on completing his apprenticeship, had to show his capabilities. To fasten the lock, a secret catch is moved to free the left-hand panel, which is then opened as a door. Behind this are the knobs of four separate bolts, which must be pushed forward individually by hand. When that is done, they cannot be pushed back. To unfasten the lock, another secret catch is moved, whereupon the middle panel may be opened downwards on hinges

THE FRONT

y courtesy of Messrs Christie, Ltd , London, W , and Colonel A D Acland, Feniton

THE BACK

Lock, 9 in by 4¾ in with four bolts not seen. The keyhole is behind the centre panel which is opened by touching a spring

(English seventeenth century)

Fig 8

along its bottom edge ; then the keyhole is seen. The key is inserted and turned in the usual way, but not a complete revolution, for when the bolts are drawn in, the turning of the key must be reversed before it can be removed from the lock. The key, 5¾ in. long (Fig. 9), is a wonderful piece of work, albeit very uncomfortable to hold. Its stem is a pipe within a pipe, to fit which a drillpin of the ordinary kind is surrounded by a tube. The key is square in cross-section through its openwork ornamentation. The knob at top may be easily turned with the fingers to rotate an inside centre piece, which has spiral and other decorations. The bit of the key has seventeen fine saw cuts very evenly made. These cuts and the sixteen intervening vanes occupy only five-eighths of an inch. If they were done by hand, which may be presumed, all praise is due to the workman. In the lock are not only wards to suit the square holes in the bit of the key, but seventeen fixed vanes accurately fitting the cuts in it. The back of the lock, also seen in the illustration, has a panel of intricate interlaced design.

A seventeenth-century lock and key, formerly on the iron door of the Treasury at Aix-la-Chapelle, but now at South Kensington, is shown in Fig. 10. This lock is over 17 in. in length.

In viewing these two periods, the Française and Renaissance, we almost lose sight of the mechanism in the art. With the exception of the French letter padlock (about 1615), security seems to have been sought in elaborate arrangements of wards. The bolts were usually spring bolts, so it was not necessary for the key to turn right round, and thus a good many wards were used that would not have been possible otherwise. The keyhole was often hidden, and some secret knob or other part had to be moved to discover it.

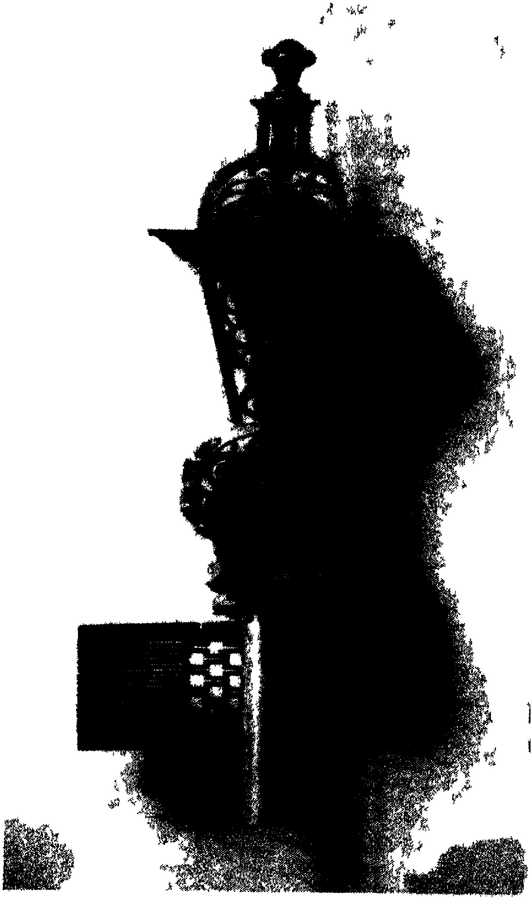


Fig 9

KEY OF LOCK SEEN IN FIG 8

The work done by the English during the Mediaeval and Renaissance periods is not as noticeable as that produced on the Continent. South Kensington has one show-case of old English locks, and several of French and German. Even the well-known lock plate on St. George's Chapel, Windsor, is ascribed to Quintin Matsys (Wyatt) ; and we know that although, at an early date, the grilles around the tombs of Henry III, and of Eleanor, Edward I's queen, were done by Englishmen, foreign workers were being constantly invited over, even down to the end of the seventeenth century, when Tijou designed the gates of Hampton Court Palace. But to England probably is due the credit of decorating the stock lock, and certainly the combination of pierced bright or black iron over the strongly marked grain of oak is effective. One of the specimens on view at South Kensington is a rim lock of wrought iron, gilt, measuring about 14 in. by 8 in. by 2 in., with the Royal Arms and supporters used by Henry VII and Henry VIII. This is an English lock of the early sixteenth century from Beddington House, Surrey. It is said that Henry VIII carried it about with him when he travelled and had it screwed to his bedroom door wherever he stayed.

A locksmith of renown for design and workmanship towards the end of the seventeenth century was Johannes Wilkes of Birmingham.

To get a good idea of the keys of the last century, one cannot do better than visit the collection of chamberlains' keys, bequeathed by Mr. Octavius Morgan to the British Museum in 1888. They come from Spain, Portugal, various German States, and Denmark. The times and Courts of the English Georges are well represented amongst these eighty odd specimens. Two unnamed ones are double-ended pipe keys, drilled right through from end to end, and having

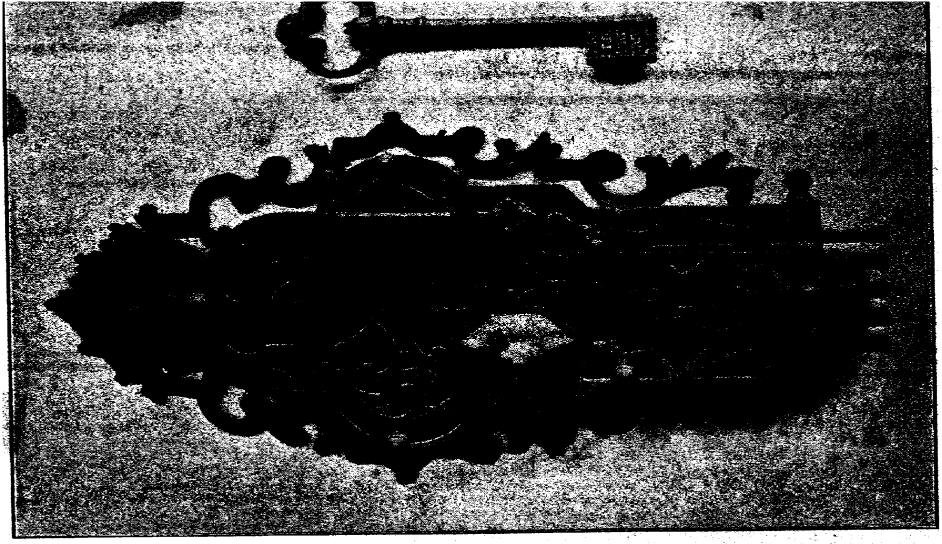
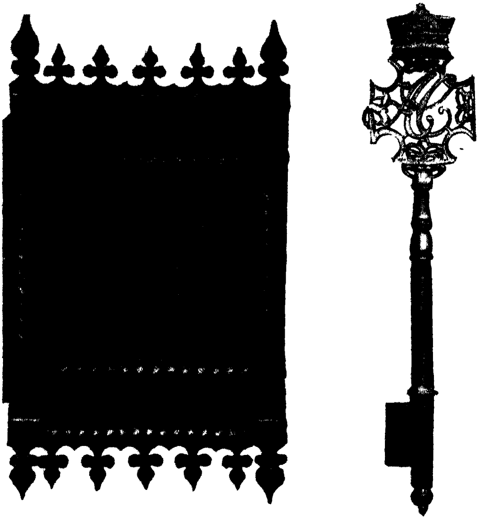


FIG. 10

LOCK, 17¼ IN. BY 9½ IN., SURROUNDED BY OPENWORK BORDER OF SCROLLS
It has five bolts, seen on the right. The key is 7¾ in. long

circular sliding bows that can be pushed up over either bit to make a handle for the other ; they are nearly all gilt, and their bits are in many cases beautifully warded ; as for the art of their bows, with the exception of some of the earlier ones, they are decidedly heavy. In at least one of them, the emblematic and official idea is so paramount that the key-bit has disappeared altogether, leaving only the bow and stem.



By courtesy of Messrs James Gibbons, Ltd

FIG 11

GOTHIC LOCK PLATE AND KEY

These emblems of office suggest to us the symbolical ideas that have, as it were, hung about keys in all ages, prominent among them being that attaching to the presentation of a key to the Jewish Rabbi on his institution, representing that in future the duty is his of unlocking and exhibiting sacred truths to the people. To those doctors of the law who did not do their duty, came the condemnation: "Woe unto you, lawyers! for ye took away the key of knowledge. . . ." There are many other Scriptural references to the symbolical use of the key as an emblem of power and authority that will at once come to the mind. These ideas, too, survive in folk-lore and superstitions, keys being used as talismans to prevent the entry of witches into houses, or held by gipsy women when prophesying or fortune-telling. (Dillinger)

CHAPTER IV

FOUR FAMOUS LOCKS

FEW are likely to dispute the claims of the Barron, Bramah, Chubb, and Yale types of lock (here named in the order of their appearance) to be regarded, on account of the service they have rendered to mankind, as the four famous locks of recent times.

Barron's Lock. Mr. Robert Barron's lock, patented in 1778, is celebrated for the fact that it contained the first double-acting tumbler. It marked an epoch in the history of the trade for the reason that the principle of security which it represents is the one most approved to this day. The inventor recognized the defects not only of wards but of the single-acting tumbler, which as long as it was lifted high enough, might be over-lifted to any amount without impeding the bolt. Strictly speaking, the pin tumblers of the ancient Egyptian lock were not double-acting, although, in conjunction with the key, something like the same effect was produced. That is to say, if any pin tumbler was not raised enough, its lower end remaining in the bolt prevented the moving of the bolt ; if any pin tumbler was raised too high, the peg on the key, or whatever it might be which caused the over-raising, would be partly in the bolt and partly in the staple, and so detain the bolt in the locked position. Fig. 12 illustrates a Barron lock. The bolt *a* is a broken view to show the two tumblers *b* and *c* pivoted to the case of the lock, and kept in position by the spring *d*. The stumps *e* and *f*, which project upwards from the tumblers, enter slots in the bolt. If both tumblers are correctly lifted together, the stumps *e* and *f* come in line with gatings formed in the bolt, which is then free to move. If either tumbler is insufficiently lifted or over-lifted, its stump takes a position below or above the gating in the bolt and so prevents its movement. In his specification, Mr. Barron claims "the gating or racking to allow a stump on the tumbler to pass through the bolt, or an opening in the tumbler to allow a stump on the bolt to pass through." The second alternative in this claim seems to cover the familiar lever, but it does not appear that Mr. Barron applied it. It will be noticed from the illustration that when the stumps are on the tumblers, those tumblers, if two or more in number, must be of different lengths, so that the respective stumps may occupy different positions along the line of the bolt. This arrangement then necessitates a series of slots and gatings in the bolt; in fact, there must be a gating for each stump, and a slot or rack at the end of each gating to admit of the rise and fall of the stumps.

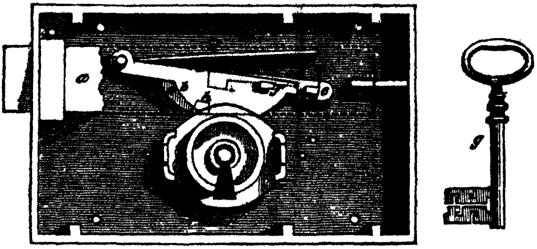


FIG 12

BARRON'S LOCK WITH TWO DOUBLE-ACTING TUMBLERS

Round the keyhole are wards

Mr. Barron was not only the first to apply the double-acting tumbler, but the first to use more than one tumbler in a lock. Locks to his design are still ordered and made, although in somewhat small quantities.

Bramah's Lock. Another type of lock nearly as old as Barron's, and still being made in a style closely resembling the early models, is the Bramah lock. It is undeniable that the design is good, although the detainers are visible through the keyhole. Mr. Joseph Bramah's first patent specification, dated April, 1784, is interesting. In it, at some length, he reviews certain methods of providing security in locks made before his invention, and lays down what he considers should be the aim in lock design. Soon after the date of the first patent, he published " A Dissertation on the Construction of Locks, containing first—Reasons and Observations, demonstrating all locks which depend on fixed wards, to be erroneous in principle and defective in point of security. Secondly—a Specification of a lock, constructed on a new and infallible principle, which, possessing all the properties essential to security, will prevent the ruinous consequences of house robberies, and be a certain prevention against thieves of all descriptions ; by Joseph Bramah."

At the time Mr. Bramah wrote his " Dissertation," housebreaking had risen to a great height in London, which caused the public to look into the nature of the fastenings of their doors and their money depositories. The warded lock was the kind almost universally employed, Barron's lock being at that period little known. That Mr. Bramah thoroughly understood the principle, defects, and insecurity of the warded locks is clear from his writings ; and it appears that, although he appreciated the ingenuity of Mr. Barron in the construction of his double-acting tumbler, yet he

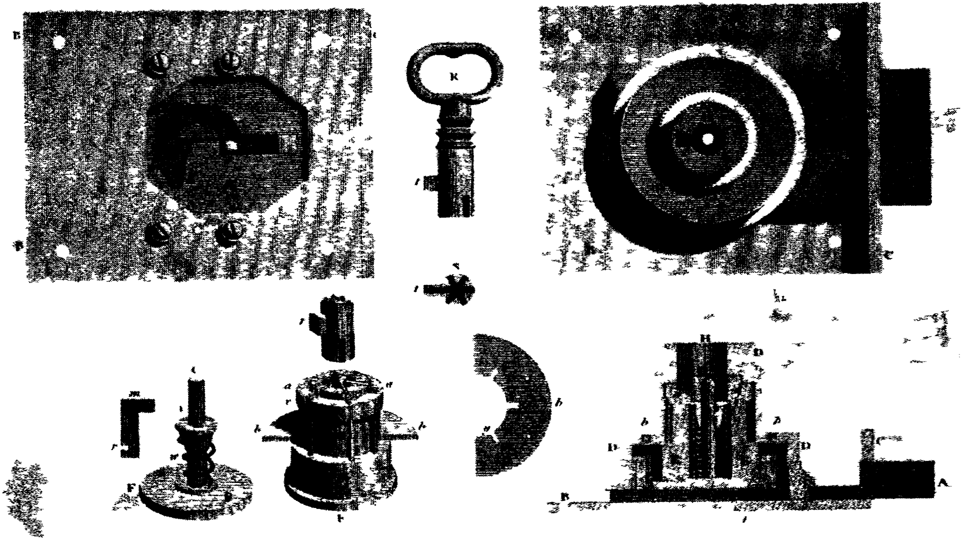


Fig 13

BRAMAH'S LOCK AND KEY

considered it insecure, albeit capable of being made secure.

From his remarks generally and from his criticism of the Barron lock, which Mr. Bramah said gave some indication of its internal arrangement and the form of key required to open it, one is led to conclude that Mr. Bramah had not conceived any other method of picking locks than by taking impressions of the wards, or from the mechanism, and the fashioning of a key accordingly. The mechanical or tentative method of picking locks was probably unknown at that time.

Fig. 13 shows the construction of a Bramah lock as in the course of time it was made.

To the main plate *B* of the lock on which the bolt *A* slides—the bolt head passing through a hole in the fore-end of the plate in the usual way—is fixed the case *D*, which has a circular hole to admit the key stem and a groove for the nib *t* on the key. There is screwed to the case the circular locking plate *b*, made in two halves for convenience. This plate *b* has a number, say, six, for example, of radial notches cut from the inside edge in an outward direction for a certain distance. A barrel *E*, made to rotate in the case, has a central keyhole and, like *b*, has six radial grooves or slots. To the end of *E* is screwed the circular plate *F*, in which is fixed a drillpin *G*, as well as another pin *f* on the underside to fit in a slot in the bolt. In the grooves in *E* are six sliders (*m*), each with an inward formation projecting into the cavity of the barrel. A spring fitted over the drillpin bears against the underside of these projections, and keeps the sliders in their extreme outward position. In the outside edge of each slider, at any selected position so that they shall not be alike, but preferably all different, is a notch which, normally, when the sliders are pressed outwards by the spring as far as they will go, is nearer the mouth of the keyhole than the locking plate *b* is. In the locked position the sliders are not only in the grooves in the barrel *E*, but are in the notches in the fixed locking plate *b*. Obviously the barrel cannot then be rotated. The key, of the pipe variety, has in its end six radial cuts of different depths corresponding with the positions of the notches in the outside edges of the sliders. When the key is inserted, the cuts on its end fit over the projections of the sliders ; and as the key is pressed inwards, the sliders, too, are pressed inwards, but not all to the same degree and not to a definite stop. The amount of movement imparted to each slider depends upon the depth of the cut in the key over that particular slider. If the cuts in the key correspond respectively with the notches in the sliders, it will come about, when the key has entered the lock to its utmost, that all the notches in the sliders will be in line with the locking plate. The locking plate will then offer no obstruction to the rotation of the barrel, which will carry the sliders with it when the key is turned. With the barrel rotates plate *F* fixed to it, and so by means of the pin *f* on its underside the bolt is moved.

Chubb's Detector Lock. In his imagination the Marquis of Worcester had a vision of a detector lock. That genius, about 1640, published his *Centurie of Inventions*, a list of those which he considered desirable for the benefit of mankind. Of one of the hundred, he says: " This lock is so constructed that if a stranger attempt to open it, it catches his hand as a trap catches a fox, though so far from maiming him for life, yet so far marketh him, that if suspected he might easily be detected." It was left to Mr. Jeremiah Chubb, nearly 200 years afterwards, to give the idea practical and more acceptable form by inventing the real detector lock.

In the year 1817 a serious robbery, accomplished by the aid of false keys, took place in the Portsmouth Dockyard, and a reward of £100 was offered by the Government for a lock which could not be opened by any other than its own key. No record can be found of the number of ideas submitted in the competition ; but whatever their number or character, the detector lock patented, in 1818, by Mr. Jeremiah Chubb gained the Government reward. At that time Mr. Jeremiah Chubb was in business with his brother Charles as a ship's outfitter and ironmonger at Portsmouth. Apart from the Government's independent tests, the lock passed another about the same time, as the following incident shows.

It is recorded that, after the appearance of this detector lock, a convict on board one of the prison ships at Portsmouth Dockyard, who was by profession a lockmaker, and had been employed in London in making and repairing locks for several years, and subsequently had been notorious for picking locks, asserted that he had picked with ease some of the best locks, and that he could pick Chubb's locks with equal facility. One of these was given to the convict, together with all the tools which he stated to be necessary, as well as blank keys fitted to the drillpin of the lock and a lock made on exactly the same principle, so that he might make himself master of the construction. Promises of a reward of £100 from Mr. Chubb, and a free pardon by the Government, were made to him in the event of his success. After trying for two or three months to pick the lock, during which time he repeatedly overlifted the detector, which was as often undetected or readjusted for his subsequent attempts, he gave up, saying that Chubb's were the most secure locks he had ever met with, and that it was impossible for any man to pick or to open them with false instruments.

It is reported that to test the Chubb detector lock for durability also, one of them was connected up with a reciprocating part of a steam engine, and by it was locked and unlocked upwards of 460,000 times consecutively without any appreciable wear taking place on levers or key.

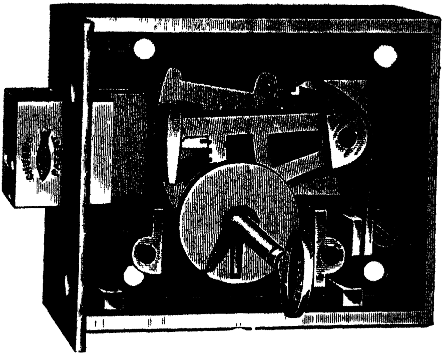


FIG. 14

CHUBB'S DETECTOR LOCK WITH SIX LEVERS, AND BARREL AND CURTAIN

The original lock, which had four levers, was improved by the successive patents of Mr. Charles Chubb, his son John, and others, in 1824, 1833, 1846, and 1847. The barrel and curtain, and the false notches in the middle bar of the levers, were added, and eventually the lock with six levers took the form illustrated, as a rim dead lock, by Fig. 14.

If an attempt is made to open a lever lock by means of false keys or other instruments, it is certain that one or more of the levers at some time or other during the attempt will be raised higher than the proper key would raise them. When the overlifting takes place in a detector lock, one of the levers, which is specially shaped and called the detector lever, is caught and held up in the overlifted position, as seen in the illustration. It does not matter which of the levers is overlifted by the instrument used for picking. The overlifting of the detector lever ensues, for the reason that any other lever when raised too high catches the pin fixed near the centre of the top edge of the detector lever and so lifts that lever too high. A spring with an L-shaped end above the bolt engages and keeps up the detector lever. Two effects result from this overlift. In the first place, as long as the detector lever remains up, it is impossible to open the lock with the right key or anything else, and so the would-be opener of the lock has reduced his chances. Unless he can get the detector lever down again, which is highly improbable since the other levers prevent access to it, nothing else avails. The second result of the held-up detector lever is that it informs the owner that someone has been attempting his lock, because the proper key will not open the lock when next the owner uses it in the ordinary way. All the owner has to do, however, when he finds his lock detected, is to turn the key sharply in the reverse direction, as if to throw out the bolt. This movement releases the detector lever and restores the lock to its normal locked condition.

What actually takes place during the releasing movement is this. All the levers, except the detector lever, are raised to their correct heights, bringing not only the gatings but the notches inside the front bar of the levers in line with the bolt stump. The bolt step of the key enters a secondary talon in the bolt and imparts to it a slight forward movement, during which the bolt stump enters the notches just mentioned ; this movement of the bolt raises by means of an incline on the bolt itself the L-shaped end of the detector spring, whereupon the detector lever is released and falls to its lowest position. The lock may now be opened by the key in the ordinary way.

In the first-made detector locks, a separate key was used to regulate or normalize the lock after it was detected. It was obviously more convenient to use the same key for all operations, so this improvement was made and patented in 1824.

It is probably true to say that there is no key lock made commercially which is more secure than a modern, well-made, six-lever Chubb detector lock. Skilled locksmiths regard it as a hopeless task to attempt to open without the right keys the locks which they have made. The barrel and curtain, when turned by the first instrument inserted, close the keyhole against the introduction of further instruments, and picking by the tentative method is rendered practically impossible by the false notches in the levers. In the case of lost keys, the makers of these detector locks have to force the locks open and repair them afterwards, as the quickest and cheapest way out of the difficulty.

During the early part and the middle of the last century, other kinds of detector locks were introduced by various inventors. Although their devices differed from Chubb's in detail, they were mostly based on the same idea, the overlifting of one or more levers. Some inventors brought the detector into action also if the levers were underlifted. Considerable ingenuity was displayed in some of these locks, and yet rarely, if ever, are they found now in use.

The Chubb lock brought into general use the double-acting lever. During the last century, countless locks have been manufactured in different parts of the world with levers which, if not exactly copies of Chubb's, are at any rate on the same general lines of design, this type of lever being suitable also for locks which are not fitted with detectors.

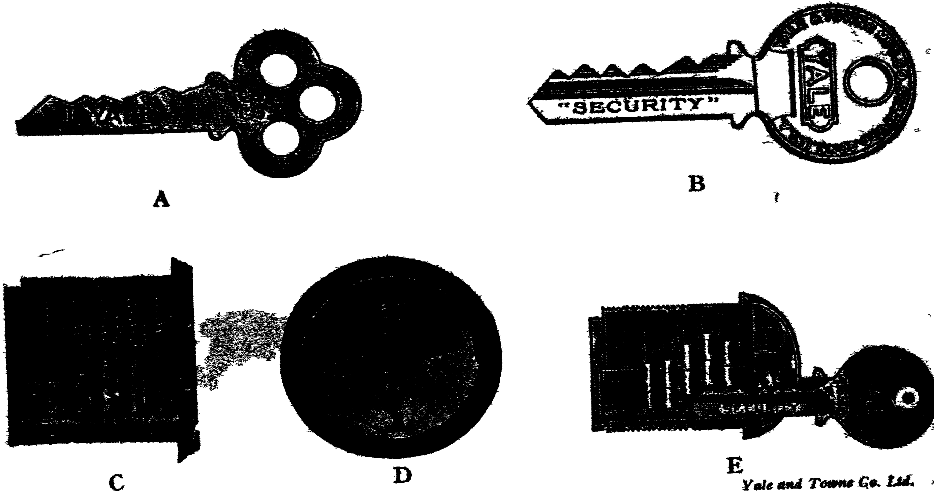
It would be of little avail and misdirected intention to fit in a lock a device like the detector, which is a refinement to provide additional security, unless the lock in other respects was made highly secure. With this fact in view, Chubb's detector locks from the beginning, and continuously, have been very carefully made and well finished, special attention being given to the closeness of the fit of the bolt stump as it enters the gatings in the levers. This closeness of fit in one place has necessitated accuracy at other points, and so it has come about that the name of Chubb and excellence of workmanship are associated. Not only so, but these locks are long-lived; and instances have been reported of Chubb locks which have been in constant use for little short of a century, illustrating the often-quoted maxim that it is cheapest in the long run to buy a good article.

All kinds of locks on the detector principle just described have been made, in sizes ranging from three-quarters of an inch to 12 in.

The Yale Cylinder Lock. Although many firms in this and other countries now make cylinder locks with pin tumbler mechanism, the credit of introducing a modern lock in that form belongs to the Yales. Linus Yale, senior, born in Middletown, Conn., in 1797, first used his mechanical gifts in designing various improvements in milling machinery. He started as a lock-maker about 1840, and devoted his attention to bank locks, which in those days were always operated by keys. Some of these locks were very intricate and costly, the best being sold at prices varying from $100 up to as much as $500 each. In or about the year 1848, Linus Yale, senior, applied the pin tumbler principle, which had been used thousands of years previously in Ancient Egypt, to modern conditions and needs. These pin tumblers were built into the case of the lock and were operated by a round fluted key.

Linus Yale, junior, after beginning his career as an artist, followed in his father's footsteps as a designer and maker of locks. He developed the cylinder lock, reducing it to its present accepted dimensions, added the rotating plug to support the key, and substituted for the round key, which was usually of large size, a small flat key whose length, about 2 in., was constant for doors of all thicknesses. The flat key at *A* (Fig. 15) was succeeded by a corrugated key, and this in turn gave place to the paracentric key illustrated at *B*, (Fig. 15) now used.

Fig. 15 shows at *C* a longitudinal section of a cylinder lock with the pins in the lowest or locked positions, and at *E* a cylinder with the key inserted part way. In the body or container is fitted eccentrically a revolving plug, in which is cut a keyway shaped to the particular section of key being used. To the end of the plug is attached a connecting bar or whatever may be needed to operate the bolt. When the plug is rotated by the key, the connecting bar turns with it and moves the bolt. The rotation of the plug until the proper key is used is prevented by the pin tumbler mechanism, which usually consists of five sets of pins. Each pin is in two parts, the lower portion which enters the keyhole being called the tumbler, while the upper portion is the driver. The springs are inserted through holes drilled from the outside of the container and afterwards filled up at their ends. Each



By courtesy of the Yale and Towne Co. Ltd.

FIG. 15.—SECTIONS OF THE YALE PIN TUMBLER LOCK
With an early type of key at A and the modern type at B

driver is a solid obstruction to the rotation of the plug, unless raised by the tumbler so that the joint between driver and tumbler exactly coincides with the joint between the plug and the cylinder, as shown in the cross-section *D* (Fig. 15). When all five tumblers are so raised by the proper key, the plug is free to rotate when the key is turned, and the rotating plug carries the tumblers with it. A slight inaccuracy is sufficient to prevent rotation of the plug. If any tumbler is not raised enough, the driver remains partly in the cylinder and partly in the plug; if any tumbler is raised too much, its end remote from the key enters the hole in the cylinder, while the rest of it remains in the plug. In either event, rotation of the plug is impossible.

By carefully regulating the depth of the tumbler holes in the plug, the tumblers are prevented from falling too low and obstructing the entrance of the key. In the proper arrangement, the key with its V-shaped cuts, acts as a wedge, and raises the tumblers as it is pushed into and pulled out of the lock.

Keys of various sections are made, and by means of these differences, together with the changes in the combination, very many different locks are produced

One firm, which makes pin-tumbler locks, fits near the front of the cylinder two steel balls held in place by a hardened screw These additions are designed to prevent drilling from the outside, by which, if possible, the pins might be divided on the line where they stop the rotation of the plug

For most applications, the pin tumbler mechanism in a cylinder forms only part of the lock. Behind the cylinder there is usually a case containing the bolt. Many people know that a front door latch of that type consists of a cylinder fitted in a hole in the thickness of the door; while on the inside face of the door is fixed a separate case provided with a bolt, a knob, and a catch button.

Mortise locks are made with the bolt case let into the thickness of the wood from the front edge, after which a cylinder on one or both faces of the door is screwed into the bolt case and locked in position by a set screw not accessible when the door is locked. It is often arranged that the front plate of the lock covers the set screws, as well as the screws which fix the lock to the door. Thus it is impossible to interfere with any of these screws without first removing the covering plate.

The rotating plug lends itself readily to various adaptations: it may turn in both directions to perform the same function, or it may do one thing when turned in one direction and something else when turned the opposite way; it may turn a complete revolution for dead lock movements, or it may turn only a short distance to operate a spring latch.

. . . . .

As lever locks and pin tumbler locks are now made in large numbers in various parts of the globe, by many firms who have adopted one or both constructions, it may be of interest here to look at the two types side by side. They are widely distinct, yet both rely for security on a set of movable detainers, which must be properly arranged before the lock will open. The lever lock varies in size according to requirements, and is often out of sight by reason of being fixed on the remote face of the wood with only the keyhole visible at the front. This makes it particularly suitable for use when appearance is a matter of importance. The pin tumbler casing passes through the wood, requiring a certain thickness of wood, and presents its circular metal front on the outside. The lever lock can be made for very thin wood. It has a key proportioned in size to the size of the lock, so that the whole range of locks comprises keys of many sizes, and thereby the opportunities for differing are increased. In the pin tumbler type various kinds of locks are made with keys of the same size. This system has great conveniences for both manufacture and use, but there is the objection that a larger number of keys than otherwise would be the case may enter, although not necessarily open, locks to which they do not belong, unless the makers vary the sections of the keys so much that this point loses its significance. In a lever lock the key acts directly on the bolt, and the amount of throw of the bolt must bear some relation to the size of the bit of the key, unless, at extra cost, means are taken, if possible, to obviate this. In the pin tumbler lock, the key rotates a plug from which a suitable connection to the bolt is made, and any reasonable length of throw of bolt can be given without difficulty. There is no need in this kind of lock to lengthen the key when the door is unusually thick. In a lever lock the levers are not seen through the keyhole ; whether distant or not from the eye, they are out of the direct line of vision. In a pin tumbler lock the foremost pin may frequently be seen close to the front through the keyhole, the others being in a row behind it. The insertion of the key into a lever lock is idle motion : during the first portion of the turning movement the levers are lifted, further turning moves the bolt, still further turning allows the levers to fall, and withdrawal of the key is idle motion. The insertion of the key into a pin tumbler lock lifts the tumblers, turning the key moves the bolt, and withdrawal of the key allows the tumblers to fall. There is no idle motion. In a lever lock, the key acts on the levers at a point usually part way between the fulcrum and the entrance of the gating through which the bolt stump passes ; this results in magnification of the lift sometimes by as much as two to one. That is to say, if one step of a key is one-sixteenth of an inch longer than another, the longer step raises the lever one-eighth of an inch more than the other on the arc or rack where the bolt stump enters the gating for the drawing in of the bolt. This magnification of lift is of considerable value for security and differing purposes. With the pin tumbler construction there is no such magnification, and it is impossible to lift the pin tumbler more than measurement on the key indicates. On the other hand, the lift of the pin tumbler is definite, and its effect more easily calculable than the lift of a lever, by reason of its directness, and the absence of erratic movement due to freedom at various scattered points ; on this account a small variation in the lift of a pin tumbler may make an effective difference. The number of levers in a lever lock can be altered more readily than the number of pin tumblers in the other type, if a departure from the usual practice is desired.

CHAPTER V

HOUSE DOOR LOCKS AND PADLOCKS

DISREGARDING for the present the front door, the locks on the other doors of a house, if key locks of any kind are fitted, are usually two-bolt mortise locks for the more important doors and two-bolt rim locks elsewhere. With either kind, there is a latch bolt operated by a knob or handle on both sides, and a dead bolt controlled by a key from both sides of the door. Internally the two kinds of lock have similar mechanism ; the rim lock, however, which is screwed to one face of the door, may be thicker than the mortise lock, and is often made so for the sake of additional strength.

It is not known who invented the mortise lock, nor the date of its appearance. Its chief advantages are that no part of the lock when fixed can be seen on either side of the door ; it cannot be removed from either side when the door is closed ; the keys are short and neat. Locks 6 in. wide are most frequently made, and are convenient because keyhole and knobs may be some distance from the door frame ; but the locks have to be mortised into the middle rail of the door, which often cuts away a considerable portion of the tenon. To avoid this, narrow mortise locks are often supplied to fit in the style of the door away from the rails ; in these, keyholes and handles are on the same vertical line, which generally is rather close to the frame, so that the user may get his knuckles grazed if he does not take care. This inconvenience, however, may be overcome by using, instead of knobs, lever handles which project inwards and keep one's hand away from the door frame. This is the arrangement frequently seen on shop doors. Fig. 16 shows one of the upright mortise or sash locks made for fitting in the narrow styles of doors.

A good deal of thought has been given by different makers to the latch-bolt action of a house door lock, with the object of making it smooth and easy in movement, whether the door is closed by a push or a pull, or alternatively by turning the knob. The more usual type of latch bolt slides, and has a bevelled head to strike the plate fixed to the door frame. Bevelled sliding spring bolts will not easily "strike," as it is called, if the bevel exceeds a certain angle. The thickness of the bolt, which is regulated in part by the thickness of the lock, combined with its projection or throw, determine the angle of the bolt. As with a thin mortise lock, it cannot be expected that the latch bolt can have both a long throw and an easy strike, a portion of the case is sometimes cut away or spread out to accommodate a thicker latch bolt head than would otherwise be possible.

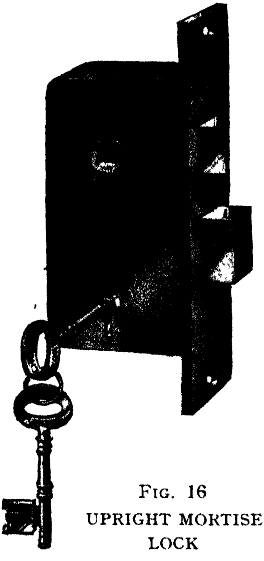
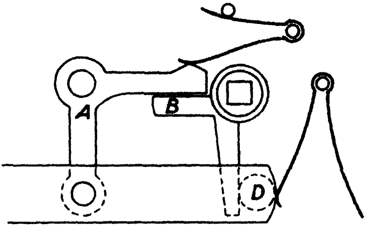


FIG. 16
UPRIGHT MORTISE LOCK

In order to reduce friction between the bevelled latch bolt and the striking plate, there is occasionally seen a bolt with a narrow projecting rib on its face. With this design, not the whole face of the bolt, but only a portion of it, rubs on the striking plate. Some latch bolts are fitted with rollers both for ordinary doors and for those which swing both ways.

The knobs or handles of house door locks preferably should turn both ways, and generally do. Several methods have been adopted to accomplish this, and at the same time make it just as easy to turn the knob in one direction as the other. Perhaps one of the best is that known as the " palace " motion (Fig. 17), which was the invention of a Mr. Young in the middle of the last century. There is a crank *A* and a follower *B*, each with two arms set at a right angle. If the follower is turned in one direction, it draws in the bolt through the medium of the crank ; if in the other direction, the follower acts directly on the bolt at *D*. The spring may be in either of the two positions shown. This motion is still used, and, when properly designed, works very well.



By courtesy of Messrs. H. & T. Vaughan, Ltd

FIG. 17

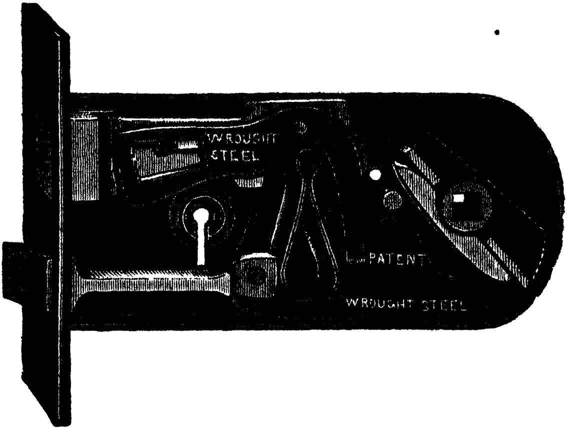
PALACE MOTION FOR OPERATING THE LATCH BOLT OF A HOUSE DOOR LOCK

In good modern practice, a helical or coil compression spring, wherever room can be found for it, takes the place of the flat metal feather or V-spring shown in Fig. 17. A coil spring works very sweetly, as they say in the trade. It rarely breaks, and, if it does, it continues to act when fitted as a compression spring on the stem of the latch bolt.

When a door is being pushed to or slammed, the latch bolt on meeting the striking plate is forced within the lock against the pressure of the spring. As soon as the latch bolt comes opposite the bolt hole in the striking plate, the spring returns the latch bolt to its forward position, which is all the spring at that time has to do. When a latch bolt is withdrawn by the turning of the knob, the spring has more work to do. As soon as the knob is released, the spring has not only to return the latch bolt, but to turn the follower and knobs against all the friction and inertia which there may be. For this reason, two springs are sometimes fitted, one to the latch bolt and one to the follower, both to operate when the knob is turned, but otherwise only one.

A latch bolt mechanism, invented by E. Tonks & Sons about twenty-seven years ago, is shown at Fig. 18. It has several good points and has been widely adopted. There is a short reversible latch bolt and plenty of room for the horns of the follower, when the case has a semicircular end. If the knob is turned in either direction, the follower operates the latch through a bent steel crank. The stump on which the crank is pivoted serves also as the pivot of the tumbler and the running guide of the dead bolt.

To fix an ordinary mortise lock takes a carpenter a considerable time. With the object of reducing the cost of fixing, the bodies of mortise locks have been made of various shapes. There have been tubular mortise locks produced at different times. For the body of these locks, the door requires no more than a hole about 1 in. diameter bored with a twist bit. The tube, however, does not provide enough space for strong, easy working and secure mechanism, even when there is only one bolt arranged as a latch, which, with the key, can be shot forward or blocked so that the handles will not withdraw it. To meet the objection of insufficient space in a single tube, another type of tubular lock, made some years ago, had two tubes attached to the same face plate, one tube containing the spring bolt and the other the dead bolt mechanism.



By courtesy of *Messrs. T. Tonks & Sons, Ltd*

FIG 18

TONKS'S 6 IN. TWO-BOLT MORTISE LOCK

With lever and reversible latch bolt, both controlled by the same spring

To save any turning of knobs, Joseph Kaye & Sons some years ago introduced a push-and-pull action for house door locks. On leaving a room, one merely pulled the knob, which released the latch bolt, and a continuation of the pull opened the door. From the outside, to open the door the knob was pushed, and no more. As a variation, the same firm made a push, pull, and turn lock.

A hinged door opens in one of four ways ; it may be hinged on right or left, and it may swing outwards or inwards. If a mortise lock, provided with a key to be used from both sides, is fitted with a reversible latch bolt, that lock will suit any door, however it opens. With a two-bolt rim lock, it is a different matter. Not only must the latch bolt be reversible, but the body of the lock must be so made that either face of it will lie against the door if that lock is to be adaptable for all four ways of opening. To meet all needs, four-way rim locks have been made for many years. There was one introduced certainly as far back as 1885, and other patterns since. One method is to make a lock, and for it a separate enclosing or surrounding frame. The latch bolt is reversible in the lock, and the lock is reversible in the frame.

Much ingenuity has been directed to reversing a bolt without unscrewing any part of the lock. Some makers consider that such a feature is not worth while, especially if strength in the lock is sacrificed. If a bolt has to be reversed, it is only once at the time of purchase or previous to fixing, and it does not take long in any event.

The front door latch may be of several kinds. Some years ago, a much-favoured type was a rim latch, to be screwed on the inside face of the door, the key being long enough to pass through the full thickness of the wood. This pattern generally had a bevelled spring bolt operated from the inside by a turn or drawback knob. It is not now used so extensively, because the cylinder latch, with short flat keys, is in vogue. Another latch which has much to recommend it, including short keys, is a mortise latch. Like other mortise locks, its fixing takes time ; but, once fixed, it is more firmly secured than those which are attached to the face of the door. If a mortise latch is made also to lock, as nearly every kind of latch can be made to lock, the risk of leaving a house empty is greatly reduced. A thief who breaks the panel of the front door cannot turn the inside knob nor remove the fixing screws, which is possible with many latches.

Space has been devoted to house door locks, because these occupy such an important place in the trade. Some manufacturers make little else but such locks, which are sold in great numbers. The qualities vary considerably. Although many are light in construction and may not stand much wear, and although the security they provide is trifling, they are noteworthy examples of good value for the price charged. Tribute must be given to the manufacturers, who, by close study of the product and careful organization within and without their factories, are able to put before the public a well-finished and cheap article, which represents a good deal of hard thinking and manufacturing skill.

Padlocks are always in demand, and are put to many uses. They range in size, measured across the front, from ¾ in. to 7 in. and in weight from ½ oz. to 13 lb. The word "pad" is taken from "footpad," as this type of lock was used to secure packages on a journey when the roads were infested by the rogues who bore that name.

Padlocks, unlike nearly every other kind of lock, do not require fitting and fixing, which is one of the reasons for their popularity. As a set off, however, it is sometimes necessary to fix a hasp and staple to a door before the padlock can be utilized. It is often the case that hasp, staple, and padlock together provide an opening for the insertion of a bar or lever, by which they can be wrenched off the door. In some instances, *the portability of a padlock is a drawback. It may get lost or mislaid when not in use, or someone may tamper with it.*

A padbar, whose fixing plates are recessed into the door, the screw heads being covered by the bar itself, is superior to a hasp and staple, and makes prising a difficulty when the padlock is on. Better still is what is known as a locking bar. (See Fig. 19.) There is no loose portable lock or other part in this ; it is suitable for wood or steel doors ; it is locked in the open position, as well as when closed, to prevent removal or interference.

Fig. 19

LOCKING BAR FOR A DOOR, INSTEAD OF HASP, STAPLE, AND PADLOCK

Some padlocks have rather large slender shackles to suit both big staples and those provided with only small eyes. While such locks have their conveniences, they have also their own especial weaknesses. Of recent years there has been an increasing demand for close shackle padlocks, in which the body of the lock comes close round the staple, and the shackle is nearly as large as the hole which it enters.

In construction, style, strength, and manner of working, there is a great variety. Some lever padlocks have been made without a bolt. Nearly a hundred years ago this idea was brought forward. The levers pivoted near the bottom of the case, and their broad ends close to the opening which the shackle entered, had a single rack, and the gating extended from the broad end of the lever to the rack. The end bars of the levers directly entered the eye of the shackle, which could not be swung open until all the gatings were brought into line by the key.

Most people know that the usual way with a shackle pivoted at one end is to lock it by a bolt which enters a hole or notch in the other end. Another method is to provide the shackle with an extension at the pivoted end and lock it there. Some shackles are locked at both ends. What is known as the Scandinavian type of padlock has not a pivoted shackle, but one bent like a letter U, with one arm longer than the other. This, when unlocked, slides out of the lock until the short arm is free of the body, at which point it rotates on the long arm which remains in the body. With these locks, the key is most frequently of the flat variety, and enters a keyhole at the bottom of the lock.

CHAPTER VI

SAFE DEPOSIT, CHANGE KEY, AND SPRINGLESS LOCKS

NOTABLY in some countries on the Continent of Europe, in the United States of America, Canada, and in Australia, safe deposits are used to a greater extent than in this country, although they are becoming more popular here. The renter of a safe deposit locker gets security for his valuables at an annual charge as low as a few shillings for a small locker. He may rent one only large enough for a package of deeds or bonds, or any size larger up to a small strong room in which he can stand upright while he opens his plate chests.

The security lies not only in the lockers themselves, but in their surroundings. The groups of lockers are substantially built of steel, with doors, in many instances, a solid half-inch thick, fitted with a first-class lock. All the lockers are placed in a strong room, or vault, as the Americans call it, which is generally of reinforced concrete of great thickness for the walls, floor, and roof ; while inside this chamber is a separate self-contained inner strong room of heavy armour plate steel. A massive door, with modern devices, guards the entrance. In up-to-date deposits, there is a patrol passage round the outer walls, which the night watchman walks through at short intervals.

Various kinds of locks are fitted on the locker doors. Sometimes keyless combination locks, as described in another chapter, are used. In the English-speaking countries, the duplex key action is the favourite type. This frequently is made with two internal sets of work and two keyholes. The renter uses one keyhole, and the guardian of the safe deposit (with a smaller key) uses the other. The locks are so made that, before the renter can open his lock, the guardian must use his key, which in no circumstances can open any locker, nor can it be altered to do so. In some patterns, the guardian's key withdraws a steel shield, which covers the renter's keyhole ; in other constructions it rearranges the internal mechanism of the lock, without which the renter's key will not operate. Although a renter has access to his locker at all times during business hours, the safe deposit authorities desire to keep a record of his visits. The duplex key action lock makes it necessary for the renter to inform the guardian each time he wishes to open his locker. When the renter locks up and removes his key, the lock goes on guard automatically, so that alone he is unable to open it again.

All the renters' keys, which the guardian need not see, as they are usually in the charge of a high official, who issues them, differ from each other and have distinguishing numbers. The lockers also are numbered, but not to correspond with the keys. Thus key No. 347 may open locker No. 926. In this way the finder of a lost key is prevented from knowing to which locker it belongs.

Some duplex key action locks have only one keyhole for both keys. In performance they are similar to those with two keyholes. Fig. 20 shows a seven-lever duplex key action, single keyhole, interchangeable safe deposit lock, which slides in grooved bars fixed to the door, and then is secured by a nozzle and set screw. The renter's key is the one with the larger bit. It is a distinct advantage to have locks which are readily interchangeable without tools. When a renter gives up the tenancy of a locker, the officials change its lock, which takes less time than one minute. If the late renter had made a duplicate of his key with dishonest intent, he would find, supposing he ever had opportunity to

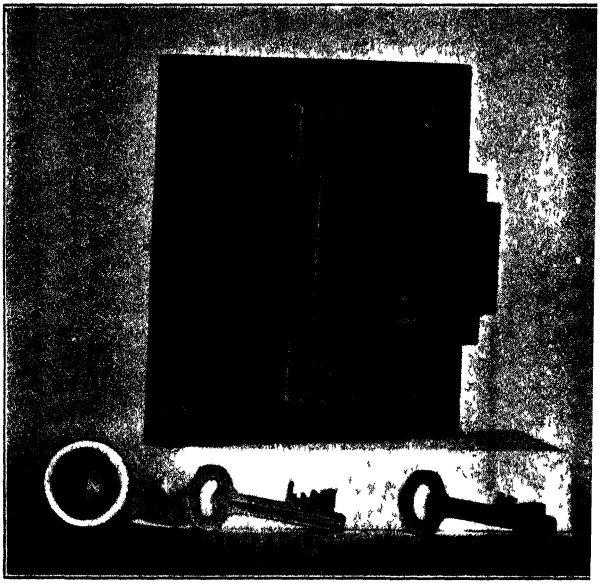


FIG 20

INTERCHANGEABLE SEVEN-LEVER SAFE DEPOSIT LOCK IN POSITION ON A DOOR

It requires two different keys to open it

try the key in the locker which once he rented, that it would no longer operate

In proportion to the population, the largest users of safe deposits are probably the people of Belgium, where, it is said, the agricultural labourers take advantage of them to safeguard their bonds. In that country, as well as in some other European countries, the favourite lock is one which is both a combination and a key lock. Fig. 21 illustrates a duplex key and quadruple letter-action safe deposit lock. The renter holds one key, and the secret of the combination, which may be any four letters of the alphabet, chosen and known only by himself. Usually to open the lock of this kind, the renter first sets up the combination with a removable dial knob, so that there is nothing outside the door to indicate the secret ; next, the guardian is called upon to perform his part, for which he uses the key with the smaller bit ; afterwards the renter with the other key is enabled to withdraw the bolt. When the renter has locked up with his key, he again has recourse to the dial knob to scatter the combination, unless that is performed automatically. In some patterns, the renter must scatter the combination before he can fully withdraw the bolt. The combination can be easily changed by the renter as often as he likes, but only when the door is open.

Parsons' lock of 1833 was the first change key lock patented in England, but old locks embodying the same idea have been seen, showing that Parsons was not the original inventor. The object was so to arrange the lock mechanism that by an adjustment, whenever desired, the key which last opened the lock could be rendered inoperative, making a different key necessary. A lock of this kind has certain conveniences. When one official relieves another, he may have the locks in his section under his own control while he is on duty. The man just relieved need not hand over his keys nor even lend or show them to any one, yet they are useless until his turn for duty comes round again.

These locks are useful also for safe deposits, as a renter may change the key when he likes, or the authorities may do so at each change of renter.

For one of the early change locks, the key bit was made of a number of pieces, which could be threaded on the stem in any order, and there secured by a nut and a pin. The inventor claimed that this construction enabled the owner to carry the key assembled, not as it had to be for opening the lock, but in some other order, so that if it fell into wrong hands, the proper arrangement of the bit would not be known. Further, as often as the owner chose, he might change the order of the levers in the lock and alter the key to correspond. This method, although fulfilling the intention of the inventor, was too troublesome.

A more recent type of change lock, or change key lock, has a number of different keys made for it. When the lock is open, any key of the set may be used to throw out the bolt. Whichever key is used for locking must be used for the next unlocking, and it remains the proper and only key for the lock as long as desired. Another arrangement, when there are several locks concerned, is to have them all alike, and a set of keys all different, and not less in number than the number of locks. Any key may be taken at random for any lock, and, being used when the bolt is withdrawn to lock the lock, is thereby identified with it until a change is desired.

This construction provides unimpaired security, and is not complicated in a lock of the lever type. The levers are very much as usual, with the gatings at the extreme end. Alternatively sliders may be used with advantage in some cases. Instead of the usual fixed bolt stump, the bolt carries a set of sliding plates, which together constitute a variable bolt stump. Each plate

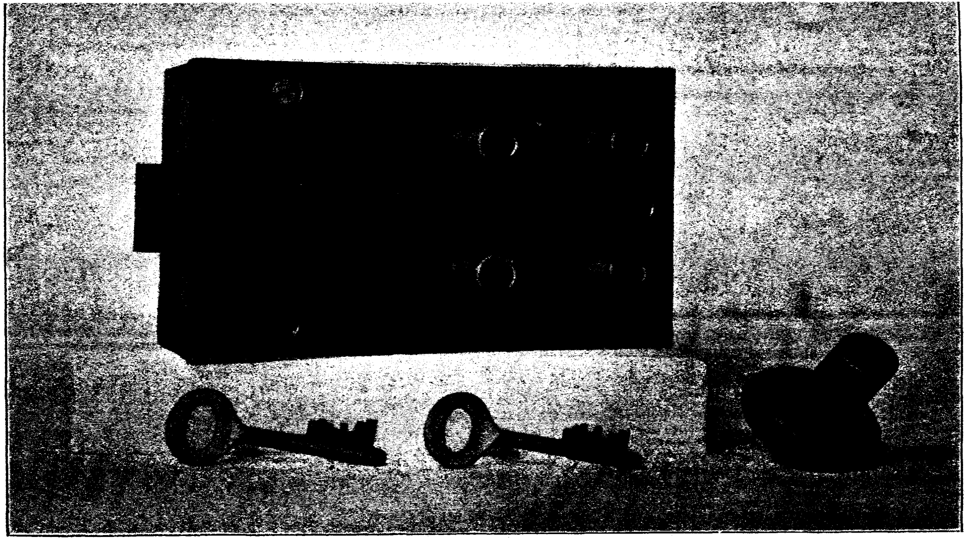
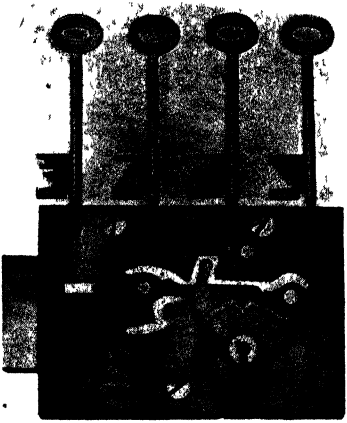


Fig. 21

SEVEN-LEVER SAFE DEPOSIT LOCK, REQUIRING TWO DIFFERENT KEYS TO OPEN IT, IN ADDITION TO A SECRET COMBINATION OF FOUR LETTERS SET BY USING THE REMOVABLE DIAL KNOB is shaped like a T, and its cross-bar slides in suitable guides on the bolt at right angles to the line of movement of the bolt. The T stems, which in size fit the gatings in the levers, project towards the gated ends of the levers. These sliding plates correspond in number and thickness with the levers, so that there is one in the plane of each lever. The cross-bar of each T on the edge opposite the projecting stems is provided with properly spaced notches or V cuts, like the teeth of a saw. When the bolt is shot out by any key, one or other of these cuts on each sliding plate engages with a V-edged stump fixed to the plate of the lock. The key used determines the lift of each lever ; the levers and the sliding plates, being engaged, move together ; and so the sliding plates get hung up in positions which correspond with the lengths of the steps of the key. On removal of the key from the lock when the bolt is shot out, the levers, now disengaged from the sliding plates, fall to zero as usual, leaving the variable stump set in a particular formation. It follows that none but the key which brought about this formation will lift the levers properly to correspond for the next unlocking.

Another style of change key lock is shown at Fig. 22. In this the front edges of the levers are toothed, and, when the bolt is shot, engage a set of pinions in which the gatings are formed. Lifting the levers by the key for withdrawing the bolt turns the pinions, so that the gatings line up with the bolt stump. When the bolt is withdrawn, the levers and pinions become disengaged. On using another key for next throwing the bolt, the levers, still out of engagement with the pinions, are lifted as the key used determines. Before the bolt is fully out, the levers and pinions again become engaged, but by different teeth. Removal of the key allows the levers to fall, and the amount of their fall regulates the degree of rotation of the pinions. Only the same key for the next unlocking will turn the pinions to a like degree to bring the gatings in the proper positions.



By courtesy of Messrs John Tann, Ltd

FIG 22

CHANGE KEY LOCK WITH FOUR DIFFERENT KEYS

Any key may be selected for use, and the others are inoperative until a change of key is made

It frequently happens that the springs of a lock, especially if of steel, are the first parts to fail. Corrosion by atmospheric effect may cause breakage sooner or later, or there may be failure from other causes. Moreover, the cost of the springs themselves, and the necessary preparation for them, are by no means negligible. For a long time springs have been regarded as the lock manufacturers' bugbear, and numerous attempts have been made to produce springless locks.

In the case of a dead lock, the only springs are those acting on the detainers, but a spring lock contains one or more additional springs to force out the bolt. Gravity-urged bolts sliding on an incline or pivoted have been used in various arrangements and are still in demand to a limited extent. While, theoretically perhaps, they should work, it happens in practice that they are not particularly satisfactory, and the lockmaker does not recommend them in preference to bolts fitted with springs. They lack the liveliness, or, as our American friends say, the snappy action, of spring-driven bolts. A little dirt or some other trifle may soon put them out of action. There is the further consideration that an extra amount of metal must go into the bolt to give it weight when a spring is not used, and this requires space, even if the cost is of little account.

Springless detainers have been tried in the form of weighted levers, but they have the same objections as weighted bolts. Perhaps the best type of springless detainer is that adapted to a double-bitted key. Several constructions, including one with sliding plates for a cylinder lock, have been adopted on this principle, which is, that while one bit of the key raises the detainers, the opposite bit prevents overlifting. The key passes through holes or gaps in the detainers, so that their form provides not only lifting edges, but limiting edges. On removing the key, the detainers are scattered or returned to their lowest or zero positions.

CHAPTER VII

OTHER INTERESTING LOCKS

Davis's Lock, patented 1799. This was made with a double chamber, and had wards on the sides of the keyhole. The key was inserted into the first chamber, and turned a quarter round ; it was then pushed forward into the inner chamber, where there was a rotating plate, containing a series of small pins which the key engaged. By turning the key, the plate was moved round, the tumbler was raised, and the bolt shot forwards or backwards. This lock is still made for certain purposes.

Stansbury's Lock, patented 1805 in this country by the inventor, who came from America, was, in some respects, like the ancient Egyptian lock. The key bit in relation to the stem was like a broom to its handle. The steps of the keys were pins of different lengths, projecting from the bit like the bristles of a broom. In the lock was a movable circular plate mounted on top of a fixed circular plate, but prevented from revolving by a number of sliding pins passing through both plates. When the key was inserted in the lock, the projections on its bit pushed back, against the pressure of springs, the pins in the lock. If these pins were pushed back until their outer ends were just clear of the movable circular plate, this plate by the turning of the key could be rotated and thereby the bolt withdrawn. If any pin was not pushed far enough, it remained in the movable plate and prevented its rotation ; if any pin was pushed too far, the projection on the key which pushed that pin passed into the fixed circular plate, and thus the key could not be turned, nor the movable plate.

Duce's Quadruple Lock, invented about 1823. This was for securing safes or chests. It consisted of four separate bolts arranged to shoot outwards, one through each side of the rectangular lockcase. Each bolt had its own complete set of levers. One turn of the key moved all the bolts consecutively. The inventor claimed that a thief would have to pick the equivalent of four locks before he could gain entrance, and that the strain on the key was less than if it had to move all the locks together.

Friend's Secret Lock, invented about 1825. This might be considered to be the precursor of the combination and key action locks mentioned in the chapter on Safe Deposit Locks. To open it required a knowledge of the combination which was set on two numbers, a guide or portable plate of a size to go in one's pocket-book, and a key. Without the guide the combination could not be set up, if known ; unless the combination was known, the guide was useless ; finally, the key was required to withdraw the bolt.

Machin's Lock, invented about 1827. The peculiarity in the construction of this lock consisted in having eccentric wards, which required a key with an expanding bit. The keyhole would admit the key only when the bit was pressed close up against the stem. As the key inserted in this state was turned, a notch in it passed over a ward set eccentrically to the axis of the key, and, as turning proceeded, the bit was gradually drawn farther from the stem. Its greatest elongation was reached when the key was operating the tumblers and the bolt. On turning the key to remove it, after locking or unlocking, the sliding bit was forced up to the stem, so that it had attained its most compact form when ready to pass out of the keyhole. The inventor claimed that the ordinary skeleton key was useless to open this lock, for the reason that its bit, if made small enough to enter the keyhole, would be too short to raise the tumblers properly.

Chubb's Combination Latch, invented 1828. This, which is shown at Fig. 23, had five separate superimposed bolts of the same width mounted on a common pivot. All had to be lifted a definite distance by the key in order that their ends projecting through the body of the latch might together assume a particular position, with their edges flush to pass between the lips of a double-chambered catch or staple. In the locked position, all the bolts were detained by the lower lip of the catch ; they had to be lifted high enough to clear this ; but if any one was lifted too high, it took a position behind the upper lip of the catch, which, like the lower one, detained it, and the door could not be opened. The ends of the bolts were formed to frustrate attempts to open the door by

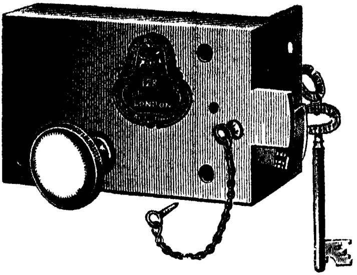


FIG 23

COMBINATION LATCH WITH FIVE SEPARATE BOLTS lifting the bolts one by one, as well as to prevent their being lifted by a thin instrument like the blade of a knife, if such instrument could be inserted between the edge of the door and its frame. On the inside of the door a knob lifted all bolts simultaneously. Latches of this type are still made by the firm bearing the inventor's name, as well as by others. Some are made also to lock by an extra turn of the key.

Gottlieb's Lock, patented 1829. In this a piece of paper covered the keyhole, and became torn by the key or any instrument inserted in the lock. The owner was made aware by the condition of the paper if there had been any attempt to open the lock. The paper was secured by means of a folding shield kept down by a spring catch, which could not be released for the insertion of a new piece of paper except by the proper key.

Tann's Reliance Lock, patented 1843. This was distinctive in the guards on one, two, or more levers. These levers, instead of being flat all over, were formed with upturned segments curved to follow the path of the key steps which lifted them. Lying on each of these levers was an ordinary flat lever behind the guard of the lever below. These plain levers were the guarded levers, as they could not be reached and independently lifted by an instrument which did not clear the guard on the adjacent lever. For this purpose the keys were provided with L-shape cuts, in addition to the steps. Alternatively, the guards might turn downwards or partly up and partly down.

Cotterill's Climax Lock. This, which was patented in 1846, had radially-disposed sliders like the Bramah lock ; but, instead of sliding parallel with the axis of the key, they moved in radial channels at right angles to the key. The key had on its outside longitudinal sloping cuts or grooves, differing in depth and in angle relative to the axis of the key. As the key was pushed in the lock, the sloping grooves in it forced the sliders outwards until notches in the sliders coincided with the circular path of the rim of a barrel, which was then free to rotate in the body of the lock when the key was turned. One slider pushed too little or too far would prevent the rotation of the barrel, and movement of the bolt depended upon rotation of the barrel. The inventor fitted a detector in this lock.

Aubin's Vibrating Guard Lock. This, resembling the Bramah, but with a difference, appeared a few years later. The guards or levers, set radially in grooves, were pivoted on a wire ring, which fitted in a circular groove in the cylinder. The key was like a Bramah key, and had to be pressed down until the cuts in it came in contact with the small end of the levers. At this, the levers, pivoting on the wire ring as fulcrum, rose at their other or broad ends, bringing the notches in these ends, when the proper key was used, into line to pass a locking or guard plate like that in the Bramah lock. Then rotation of the barrel, and, with it, movement of the bolt, was possible.

At the present time, a French firm is making locks with pivoted levers or guards closely resembling Aubin's. There is the difference that the French key, a pin key with radial ribs, which are milled concavely to various depths, does not force the small end of the levers downwards, but outwards.

Hobb's Protector Lock. Mr. A. C. Hobbs, who came from America about the middle of the last century, was undoubtedly one of the leading authorities on the construction of locks at that time. He founded the business of Hobbs & Co., which, in the early fifties, had an establishment in Cheapside, London. Being convinced that nearly all locks suffered from one and the same defect, he devised and patented, in 1852, the protector lock. In this the bolt stump, instead of being rigidly attached to the bolt, was free to move within limits. This was accomplished by fixing the stump in a separate plate, which was arranged to pivot freely on the bolt, the pivot being placed some little distance from the stump. When the proper key was used, the stump passed through the gatings of the levers, and, meeting no obstruction, kept its normal place. If pressure was put on the bolt in the attempt to pick the lock, the plate turned on its pivot as the bolt stump came in contact with the levers. This movement caused an arm of the pivoted plate to swing in front of another stump fixed in the case of the lock, and this formed a direct obstacle to the withdrawal of the bolt. When pressure on the bolt was removed, the plate, carrying the bolt stump with it, returned to its normal position under the action of a light spring provided for the purpose. Means were taken in a later model to prevent the insertion of an instrument which might be used to keep the bolt stump from movement while pressure was applied to the bolt. Locks on the protector principle are being made at the present time.

Newton's Lock, invented by L. M. Eiler, of Copenhagen, about 1854. This was a magnetic lock not requiring a key or a keyhole. The inventor stated that the foundation plate of the lock must be of brass or some metal not affected by a magnet. Within the lock, arranged in grooves or channels, in any arbitrary manner, was a series of steel slides. These held the bolt, and for unlocking had to be moved in a given and prearranged order and succession. The owner required a plan showing the positions of the slides to be moved, which had to be done with the aid of a powerful magnet held against the outer plate of the lock.

Some twenty years ago an interesting lock, suitable more particularly for cupboards and drawers, was invented in Denmark. Its detainers were flat steel discs housed to rotate in a bent ring forming a cylinder. Each disc had a notch on its outer edge, and when all notches lined up together there was no opposition to the indrawing of the bolt. The key, of the pin variety, entered the lock through holes in the discs, the axis of the key being eccentric to the axis of the discs. It was arranged that when the key was turned, the steps of the key engaged the discs and carried them round until a point was reached, where, by reason of the eccentricity, engagement of the key ceased. Consequently rotation of the discs ceased here, and they were properly set if the right key had been used. Further turning of the key drew in the bolt. Very thin non-rotating washers separated the discs to prevent one from moving another by friction. The discs were laid in a thick grease, which not only served as a lubricant, but as a check to unintended movement. This lock did not require springs.

Recently there has appeared another lock of Scandinavian origin, which has a cylindrical body containing rotating discs, without springs, separated by non-rotating washers. The key, with a stem of *D* section, passes through D-shaped holes in the centre of the discs. The cuts on this key for differing purposes are radial, springing from the middle of the flat side of the *D*, so that the difference between one cut and another is an angular difference. The deepest cut reduces the semicircular stem of the key to a quarter circle at that point. As the key is turned, the bottom edges of the cuts, one after the other according to the angle, come up against the flat sides of the semicircular holes in the discs, and rotate them until notches on their outer edges all line up to admit a bar, which otherwise prevents withdrawal of the bolt.

Years ago the several bolts of a safe door were shot out and drawn in by the key. This was a warded key, generally more or less complex, the box of wards being fixed in the bolt case behind the door plate of the safe. The key had to be somewhat large, not only for strength on account of the work it had to do, but to throw the bolts the required distance. The practice is now to put the bolt-throwing strain on a separate mechanism operated by a handle, and use a small lock for fastening the bolts when thrown out. Such safe locks are not essentially different from locks of other kinds, frequently taking the form of a drawer lock. Others, however, are of special design, although most of them contain levers. It is usual so to construct the best safe locks that there is very little space to contain explosives if passed through the keyhole, and further to provide vents for the rapid escape of the destructive gases should an explosion take place.

Prison locks are fixed on the outside of cell doors. They are strong and fairly large, with about three levers. Usually they are fitted with a substantial bolt, which is held back by a catch when withdrawn by the key. This bolt springs out when the door is slammed, and can be double-locked by the key. On the outside is an indicator or finger, which takes one of three positions to show whether the bolt is drawn back, single-locked, or double-locked.

Locks for multiple control are attractive on account of their advantages in banking, legal, and other circles Two or more separate locks will provide the necessary security, but it is usually more convenient to have one lock only. Such lock may be fitted with a bolt having double or triple throw, each throw operated by a different key, but there is not always room for the extra projection of the bolt.

There are several known patterns of locks with single throw which are opened by first using one key, followed by another in the same keyhole, although locking can be performed by one key only. There are other types with more than one keyhole requiring all persons in control, when unlocking, to co-operate simultaneously. An example in mind is a triple control lock with one bolt and three keyholes, one for each of three different keys. To open the lock two of the persons insert their keys, turn them to a stop, and leave them so. Then the third person, who may be any one of the three, turns his key which draws in the bolt, after which the three keys are removed. Any of the three persons using his own key in the particular keyhole which it fits can lock in the absence of the others, but all three keys must be used for the next unlocking.

Another type of dual control lock with single throw and single keyhole requires two different keys to be used when locking as well as unlocking. One of the keys operates the bolt but will not do so either for locking or unlocking until the other key has been first turned in the lock and removed. The first used key cannot in any event move the bolt but prepares the mechanism for the second key to do so.

CHAPTER VIII

DIFFERING AND MASTER KEY SYSTEMS

THERE are two ways by which a lock may possibly be opened other than by the key that was made for it. One is by picking, which is done by the use of special instruments designed for the purpose ; the other is by a key which, although not made for that lock, happens to fit it. It is not proposed here to say anything more about picking. With regard to the second risk, it will be understood from what has been written in previous chapters that the extensive employment of keys of different sizes and shapes goes a long way in the right direction. By such means, the number of keys which will enter the keyhole of a particular lock becomes reduced. A manufacturer, however, cannot constantly be changing the sizes and shapes of the keys. Even if there was a large enough variety at his disposal, it would not be economically practicable to do so. Especially is this true under modern conditions of production, which give the cheapest and often the most accurate results when component parts in large quantities are made alike. It follows that the manufacturer seeks to make different locks, if not with like parts for all, at least with as many parts as may be identical in each lock, and the others altered only to the smallest degree. It is when a quantity of different locks has to be made with key blanks all alike, that differing, as generally understood in the trade, enters into the case. In these circumstances, all the keys in the batch will enter each and every lock, and the differing must be accomplished by the cuts on the keys and the corresponding arrangement of the internal parts of the locks.

To some extent, the question is one of mathematics for working out the permutations. It is not, however, a question of pure mathematics with arbitrary factors. In this way, huge totals, having little more than an academic interest, can be obtained, and are sometimes presented for consideration. These cannot be accepted at face value for manufacturing purposes. Instead, it is important, first, for the practical man with the particular lock and key before him to decide what constitutes an effective difference. Then perhaps it may be figured out how many such differences are possible in the series. The number of detainers has a direct bearing on the result, but the question embraces more than this. There is the matter of size, for instance. A lock having two or three large levers capable of plenty of movement, and a key to correspond, might be differed in larger quantities than another lock with four levers of less size and movement. Quality, apart from the number of detainers, enters into a case more than a little, because locks well fitted at all points are capable of a greater number of differences than those with too much freedom in the guides and bearings. This remark applies also to warded locks, which, however, are not being specially considered here.

When the conditions are known, then can be determined, as has been said, the least change which will make a practical and effective difference when reliance is placed on the detainers alone. Working upwards from this, the total number of changes or differences is largely a matter of calculation. Some very considerable and useful figures may result, especially for well-fitted locks containing four, five, six, or more detainers, whether these be pins, levers, sliders, or any other kind.

For every increase in the number of detainers, the number of changes increases rapidly, not necessarily always according to one and the same formula. Here, again, it is to some extent a question for the manufacturer to determine beforehand on what lines he will proceed. It may be sufficient to give one example and say that if 1,200 locks, having four levers, can be differed, it will be possible to differ 6,000 similar locks having five levers, and 36,000 if they have six levers.

When the maker has run through the series of different locks all having keys of the same size and kind, he may, if a still larger number of changes is required, alter the size or style of key once or more times, or vary the dimensions of certain parts of the lock, and after each alteration go through the series again. With this in mind, one has no difficulty in understanding what large numbers of different locks can be made when the problem is attacked methodically. At the same time, it has to be remembered that the manufacturer, however careful he is to make a set of his own locks differ from one another, cannot be sure that some of them may not be opened by another's keys, for no one person can know all that other people have done or are doing.

It used to be thought that when parts of locks had been prepared to a certain stage, the actual differing must be left in the hands of skilled locksmiths. It is now known that more certain results can be obtained mechanically. Keys can be stepped, and in lever locks the levers gated and correctly shaped for the particular length of key step, with great exactitude on machines. Some makers, instead of having all the differing elements machined, prefer to provide the locksmith with stepped keys, and leave him to fit the internal parts of the locks to correspond. In either case, if the keys are cut to tables on machines fitted with indexing fixtures, the maximum number of changes will be given with the greatest certainty.

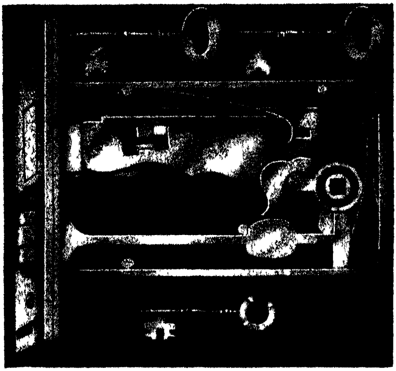
The preceding particulars in the present chapter deal with what may be called unrelated or independent differing, the term being used to convey the idea that it does not matter how widely the locks and keys vary from one another when it is the first consideration that they shall differ. In a set of different locks under a master key, other conditions are imposed, and the different locks and keys are in a sense related. The advantages of the master key system are undeniable. The governor of a prison, the manager of an hotel, or the proprietor of some factory or other establishment wishes to carry one key, a master key, and with it to be able to open all the locks on the premises, while the various subordinates have keys different from each other, which will open only certain locks. Sometimes between the master key and the subordinates' or servants' keys come sub-master keys, designed to open all the locks in a particular section, but no more. Each chambermaid in an hotel is usually provided with a sub-master key with which she can open the doors of all the rooms in her charge on her own particular floor, these doors being fitted with different locks, so that each guest's key will open only one door. In asylums and prisons, a similar system prevails, certain officials with sub-master keys being enabled to obtain access to all the wards in a particular wing or section of the building which the under-warders, with inferior keys, cannot do. The master key is sometimes called the grand master key, when under it there are several sub-master keys.

Sometimes in the trade the individual locks under a master or sub-master key are said to be suited; their keys are called suite keys; and the system generally is known as suiting. The descriptive words, derived from the French *en suite*, are frequently pronounced as they would be in a tailor's shop.

Suiting was adopted many years ago when warded locks, which lend themselves readily to the system, were the fashion. Dr. Plot, in his *History of Staffordshire*, published in 1686, writes: "They make them in sutes, six, eight, or more in a sute, according as the chapman bespeaks them; whereof the keys shall neither of them open each other's locks, yet one master key shall open them all; so that these locks being set upon the doores of a house, and the inferior keys kept by distinct servants, tho' neither of them can come at each other's charge, yet the master can come at all of them."

There are several ways, and better ways now than the original method, of reaching the end in view, although at times it is necessary to resort to something resembling the old practice. The choice of the method to apply depends largely upon circumstances, not least of which is how much the customer will pay for the convenience. To a greater or less extent, some loss of security is involved in a suiting system, although in the best it is reduced almost to a negligible point. When the most approved means are adopted, there is no more loss of security than this, that two or more different keys—the servant's key and the master key, at least, and possibly a sub-master key—will open each lock in the series, when the highest security is gained if only one key will open a given lock.

In most suiting systems, the master key and the inferior key enter the same keyhole in the lock. This means that superior and inferior keys are alike in certain dimensions, if only in the size of the stems. This, however, need be no objection if in other respects the keys of different ranks are widely dissimilar. An important point in suiting is to make certain, if possible, that an inferior key cannot be altered to a master key by filing or otherwise removing any of the metal. Mention is made below of several methods designed to safeguard this.



By courtesy of *Messrs James Gibbons, Ltd*

FIG. 24

GIBBONS'S TWO-KEYHOLE LOCK

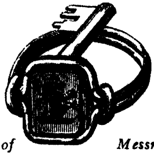
The master key (shown below the lock) is different in size and shape from the servant's key

In 1898, James Gibbons patented a lock having two keyholes different in size. (See Fig. 24.) The servant's key enters one keyhole and the master key the other. Both keys operate the same bolt and actuate the same set of levers, which are of extra length, but have only the usual gatings and racks. The servants' keys in the series are all different, and the levers are shaped and gated to suit. Afterwards the levers at another part of their length are so formed on their edges that the master key, although different in size and shape from all the servants' keys, will lift the levers to the same extent as the proper servant's key for each lock will. Other manufacturers have adopted this system.

There is a Kaye lock patented which has two sets of ordinary levers, but only one keyhole. In this, the master key is larger in the bit than the servant's key. The master key, when turned, actuates the first set of levers and operates a sliding plate or runner by which movement is transmitted to the bolt. The servant's key, by reason of its smaller bit, fails to touch the first set of levers as it is turned, but in its rotation it reaches and actuates the second set of levers, and puts in motion a second runner, and, through it, the bolt.

Chubb's lock, recently introduced, has one set of sliders, used here in preference to levers, containing two sets of racks and gatings. The bolt is operated through the movement of either a pivoted arm if the servant's key is used, or a sliding plate, if the master key is used. The pivoted arm has a bolt stump fitting the lower rack in the sliders, and on the sliding plate is a bolt stump fitting the upper racks. When either master or servant's key is used, the sliders assume positions quite different from the positions when the other key is used. The result is that one set of gatings in the sliders lines up truly for the passage of the particular bolt stump which is to go through, while the other set of gatings is irregularly disposed and blocks the other bolt stump.

Some manufacturers, for the purpose of suiting pin tumbler locks, adopt what is called a master ring. This, tubular in shape, fits within the container, and surrounds the plug with sufficient freedom to rotate inside the one and outside the other. Each driver pin is divided at a particular position, the positions being different in all locks in the series, while the tumbler lengths remain constant in all locks. When the master key is used, the tumblers are raised so that their top ends and the bottom ends of the lower portions of the drivers line up with the joint between the plug and the master ring. Then the plug can be rotated by the key, the master ring being prevented from rotating by the drivers, which are partly in it and partly in the container. When the servant's key is used, the upper ends of the lower portions and the lower ends of the upper portions of the drivers line up with the joint between the master ring and the container. Then the plug and the master ring together can be rotated as one piece, the tumblers being partly in the plug and partly in the master ring.



By courtesy of Messrs. Chubb & Son, Ltd.

FIG. 25

A GOLD KEY HINGED TO A SIGNET RING AND OUT OF SIGHT WHEN THE RING IS WORN

In all the four constructions briefly described above, the servants' keys can be made to differ from each other and from the master key, with the added advantage that no servant's key can be altered to another of superior rank by the removal of metal. In some of the four constructions, if not in all, it is impossible to alter sub-master keys into master keys without making an addition.

Master-keyed locks for hotels, asylums, etc., are sometimes so arranged that the master key will double-lock the bolt and prevent the servant's key from acting until the second locking is undone.

On several occasions the Chubb firm has made under a master key large numbers of locks of various sorts and sizes for the doors, furniture, and fittings of a palace or some nobleman's abode. The point of interest here is that the master key to open all the locks was of gold, and so small that it was hinged to the signet ring worn on the owner's finger When not required, the key was folded out of sight under the seal Fig 25 illustrates such a key.

CHAPTER IX

LOCKS WITHOUT KEYS

THE letter lock, in the form of a padlock as illustrated by Fig. 26, is an article still in demand. The one shown has four rings which may be independently rotated by the fingers to set up the combination which the user selects, and may alter as often as he likes. This consists of four letters which must be brought into line with the marks on the end-pieces of the lock. Then one end-piece can be drawn outwards sufficiently to free one end of the shackle, so that it may be swung open on its pivot at the other end. The lettered rings

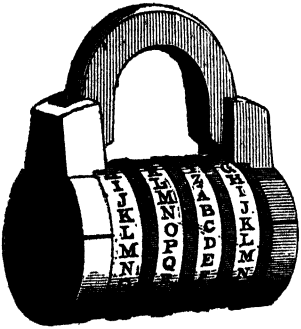

I J K L M N
L M N O P Q
Z A B C D E
H I J K L M

FIG. 26

LETTER PADLOCK OPENED BY SETTING A SECRET COMBINATION OF ANY FOUR LETTERS WHICH THE USER SELECTS have inside radial cuts or notches opposite each letter. Each of these rings surrounds an inner ring, which is mounted with freedom to rotate—but not to move otherwise—on a slit tubular bearing attached to one end-piece of the lock. The inner rings have one outside projection to fit any notch in the lettered ring, as the user decides, and one inside notch. The other end-piece is provided with a spindle on which are four studs in line, made to slide in the slit in the tubular bearing and to pass freely through the notches in the inner rings. To open the lock, the lettered rings carrying the inner rings with them must be turned to certain positions to bring the notches of the inner rings into line with the studs on the spindle, which is then not obstructed from sliding outwards, in order to liberate the shackle. By a simple arrangement, the sliding movement of the spindle is limited to a definite amount. To change the combination, the movable end-piece is unscrewed from the spindle, when the lettered rings may be placed in new positions on the inner rings. After locking, the rings are turned at random to scatter the combination. Some of these locks have more than four rings.

In Beaumont and Fletcher's play of *The Noble Gentleman*, in the year 1615, the following line occurs—

> With a strange lock that opens with AMEN.

In some verses by Carew, in *The Comedy of the Heir*, is this passage—

> As doth a lock
> That goes with letters; for till every one be known
> The lock's as fast, as if you had found none.

In the first example of this lock, supposed to have been invented by Carden, it was not possible to change the combination. M. Regnier, Director of the Musée d'Artillerie in Paris, improved it in that respect, and constructed the lock in a form closely resembling the present.

Elsewhere will be found mention of safe deposit locks which cannot be opened unless a particular combination of letters is known.

A more secure keyless lock than any hitherto named is the kind extensively used in the United States, and to an increasing degree in this and other countries, for safes, strong rooms, and other purposes. This lock, believed to be of American origin and considerably developed since, although retaining the same leading features, is a single spindle and single dial lock. It is made as a three-wheel lock capable of one million changes, or as a four-wheel lock of 100 million changes. To set up the combination of a four-wheel lock occupies about half a minute of time, as the various turning operations must be made with exactitude. Consequently a person would have to work unceasingly day and night for one hundred years to go through all the changes. Each number in a combination may be anything from 1 to 100, so the combination selected for a four-wheel lock might be, for example, 63–14–97–51. The numbers should not be related to each other, or easily remembered, as 25–30–35–40.

Fig. 27 shows the inside of a four-wheel keyless combination lock with the bolt thrown out and locked. There is seen in the illustration an arm pivoted to the bolt and extending across the top of the lock to the vee-shaped block on the case against which the end of the arm is wedged. It is plain that the bolt cannot move inwards until the arm falls, and can pass under the vee block. The method of opening the lock is explained in the next paragraph.

Sectional view, Fig. 28, shows a three-wheel keyless combination lock on the inside, and the knob and numbered dial on the outside, of a safe door through which passes a steel spindle provided with collars to prevent its being driven in or pulled out. The knob is firmly fixed to one end of the spindle, and the driver *A* to the other. Turning the knob to the right (for a three-wheel right hand lock) until the first selected number in the combination reaches for the fourth time the setting mark on the dial ring, brings the first wheel in the lock to a definite position with the notch on its edge (Fig. 27) directly under bar *F*, which is part of arm *E*. The knob is then

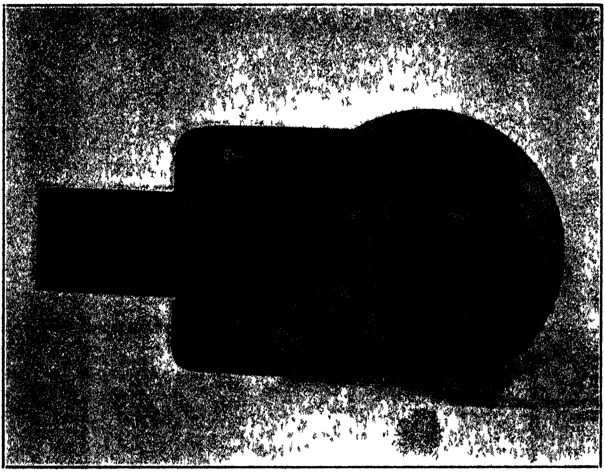


FIG 27

FOUR-WHEEL KEYLESS COMBINATION LOCK, CAPABLE OF 100,000,000 CHANGES turned to the left, that is, in the reverse direction, until the second selected number comes to the setting mark for the third time. This movement of the knob brings the second wheel to the proper position without disturbing the wheel already set. Then the direction of rotation is changed again, and the knob is turned to the right until the third selected number reaches the mark for the second time. The notches in all the wheels are now under *F*, so that the arm will fall during the next turn of the knob to the left. This turning movement takes the triangular projection on the driver into the notch on the underside

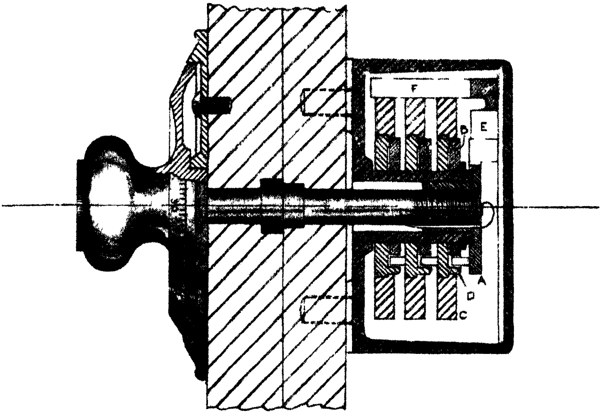


FIG. 28

SECTION OF A KEYLESS COMBINATION LOCK AS ILLUSTRATED BY FIG. 27, BUT WITH THREE WHEELS, CAPABLE OF 1,000,000 CHANGES

A	Driver	*D*	Inner ring of wheel
B.	Disc	*E*.	Arm
C.	Outer ring of wheel	*F*.	Bar on arm

of the arm, enabling the knob in the continuance of its turn to draw in the bolt.

When the bolt has been drawn in, the turning of the knob is automatically stopped. At any other time the knob may be turned indefinitely in either direction without giving any indication whether the right or the wrong thing is being done.

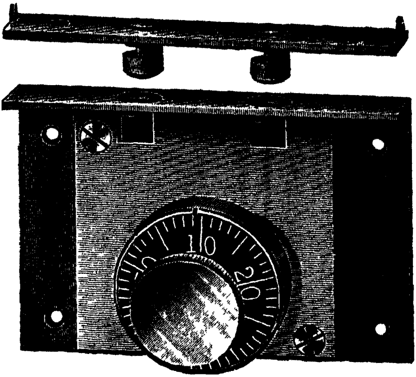
The process of locking necessitates only a turn of the knob to the right, which throws out the bolt and wedges the arm against the vee in the top of the case. A few random turns afterwards effectively scatter the combination, and the lock is immediately at full security. It cannot be opened again without going through the whole and exact performance described above.

The combination can be changed at any time while the safe is open, by a person who knows the existing combination. This has to be set up before the cover of the lock can be removed to admit the change key. The change key unlocks the inner rings of the wheels from the outer rings (Fig. 28). The inner rings, by means of the knob, are then turned to new positions in the outer rings to agree with the new combination. Then the change key is turned back and removed so that the inner and outer rings are again locked together but in another relationship.

After replacing the cover, the lock is ready for use and will open only to the new combination.

It is unwise to use absolute terms about human contrivances. Such expressions as " burglar proof " and " unpickable " are generally to be avoided. If an exception may be made, a modern well-fitted keyless combination lock may be described as unpickable. That is to say, the great majority of experts do not know how to open one if ignorant of the combination. When a lock-out has occurred, through the user's mistake or forgetfulness, skilled men, hoping to save the cost of a forcible entry, have tried repeatedly to open such locks on safes, but have failed.

In order to obviate the risk of having to get his safe or strong room opened by force, the owner should, if a keyless combination lock is fitted, make a secret memorandum of the combination in case his memory fails. If he wishes to provide against its getting into wrong hands, he may place the memorandum in a sealed envelope and deposit it with his banker.



By courtesy of *Messrs Chubb & Son, Ltd*

FIG. 29

KEYLESS DIAL LOCK FOR BOXES, OPENED BY SETTING A COMBINATION OF THREE NUMBERS

A lock similar in operation to the one just described, and made to open on three numbers, is shown at Fig. 29 in a form suitable for boxes. Owing to reduced dimensions, the number of changes is considerably below one million, and the method of altering the combination is different from the keyless lock for safes.

It is a comparatively simple matter to design a combination lock in which separate dials, rings, or spindles are operated for each number or letter of the combination. Especially is this true if changing the combination is disregarded or achieved by taking the lock partly to pieces. This perhaps accounts for the somewhat large number of combination locks brought out during recent years. Many of them have been single-purpose locks, such as for securing some parts of a bicycle or motor car. The problem is a bigger one when changing the combination is to be a simple performance which any one can manage. With a single spindle lock, the difficulties are considerably increased.

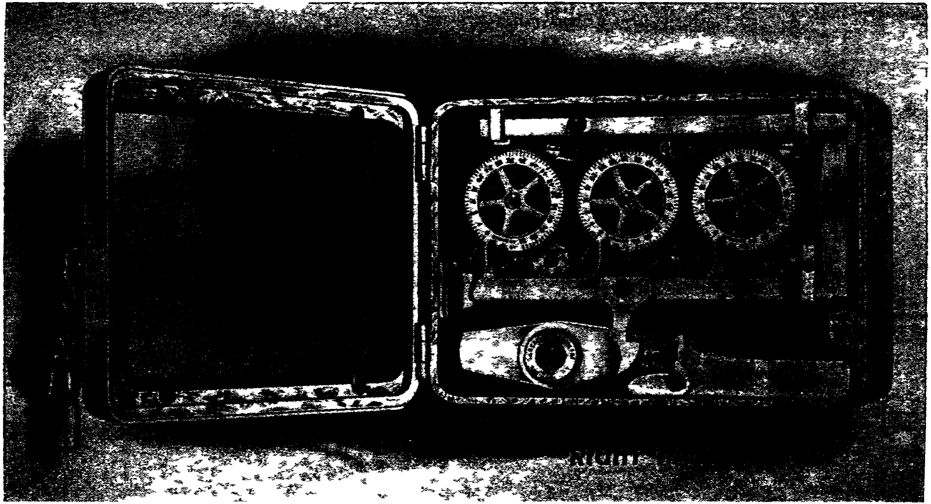
Time Locks. As far as is known, the lock patented in 1831 by William Rutherford, a bank agent, of Jedburgh, in Scotland, was the first time lock made. This was a lock requiring a key to open it after a given period of time. The inventor introduced at the rear end of the bolt a circular stop plate, which prevented the withdrawal of the bolt by the key until the plate had rotated a definite amount in order to bring a notch in it opposite the end of the bolt. The rotation of the circular plate was caused by clockwork. As the notch could be set at pleasure any distance from the end of the bolt, the time could be varied, but the lock could not be opened by its own or any other key until the appointed number of hours had elapsed. For fastening portable boxes, clock-work driven by springs was necessary ; but for stationary receptacles, a weight and pendulum could be used.

The modern time lock as used for safes and strong rooms is a much more elaborate piece of mechanism than Rutherford's. It may be used as the sole fastening of the bolts of the door, or in conjunction with locks of other kinds. It is believed that Mr. James Sargent, of Rochester, N.Y., made the first model of this variety about 1865, and subsequently improved it. There was some difficulty at first in getting bankers to adopt such an innovation; but, in 1874, Mr. Sargent sold, and himself attached the first time lock ever purchased by a banker. To-day, statistics show that there are more than 35,000 time locks in use, and there is no record of a failure of one. Most of these are in the United States and Canada, but to an increasing extent they are being fitted in this country and other parts of the world.

The need for time locks arose in America when what became known as masked burglary increased to such an alarming degree. Finding that forcibly opening or attempting to open safes and strong rooms was too slow and too dangerous, burglars adopted another plan. A gang of masked and armed desperadoes in the night would seize an official of the bank and compel him by threats, or torture, if necessary, to disclose the combinations of the locks or give up his keys. Such success followed this procedure that the method soon became prevalent, and bankers were at their wits' ends. When the time lock appeared, the burglars were told that neither the bank officials themselves nor any one else could open the safe doors before a determined time.

At Fig. 30 is seen a typical triple movement 72-hour time lock off guard ready for the opening of the safe door. The dials rotated by the clock mechanism have turned until the zero mark on each has come round to the fixed indicator, which is seen at the south-west of each dial pointing towards its centre. While rotating to this position in a clockwise direction, the three pins, which may be observed one on each dial about midway between 0 and 72, have been pressing against the arms projecting upwards from the long horizontal bar and moving this bar to its extreme leftward position, where it is seen in the illustration. This sliding movement of the bar has caused its central depending hook to pass clear of the pin, which may be observed near another hook on a plate pivoted in front of the weighted arm and acting in conjunction with it. Consequently the arm has swung downward on its pivot, and now lies along the bottom of the case. Thus there is space above the arm opposite the bushed hole on the right-hand side of the case. Through this hole may freely pass into the case a rod connected to the main bolts of the safe.

Now consider the setting of this lock immediately after opening the safe, say, at 9 o'clock one morning, in readiness for locking up in the afternoon, so that the next opening cannot take place before 9 o'clock on the following morning. Each movement is wound separately with a key provided, so that the dials rotate in an anti-clockwise direction until the number 24 (for 24 hours) on each dial comes opposite the indicator. The movements may be wound at any time while the safe is open, but it is advisable to do this first thing, so that the safe may be instantly locked in an emergency. The number of hours is calculated from the time of winding to the time of the next opening. During the winding of the first two clocks, the horizontal bar is kept stationary by the pin on the third dial. When the third clock is being wound, the movement of the pin on its dial away from the upward projection on the horizontal bar allows that bar to slide to the right. This bar cannot at the moment slide its full distance, because the lower part of its depending hook meets the obstruction of the pin on the plate in front of the weighted arm. On completion of the winding, this plate has to be lifted until the pin is high enough to engage the hook, whereupon the sliding bar



By courtesy of Fig 30 *Sargent & Greenleaf Inc Rochester New York*

72-HOUR TRIPLE TIME LOCK OFF GUARD

under the action of its spring moves the remaining distance to the right, and hook and pin become fully engaged. As the safe door is open and the rod from the bolts is inside the case, the weighted arm cannot rise. The raising of the plate, however, has brought into action a spring which tends to lift the weighted arm. As soon as the safe bolts are thrown out, and the rod connected to them no longer lies above the arm, this arm instantly rises under the pressure of the spring and automatically goes on guard with its nose opposite the hole in the case. This prevents the inward movement of rod and bolts until the appointed period of time has elapsed, when the weighted arm again falls to the bottom of the case.

For opening the safe at the proper time, one clock movement is sufficient. Additional movements give no further security against thieves, but are provided to prevent a lock-out. The most expensive clocks and watches may fail at times. By having three separate movements, there are always two for use, if the third has been removed for cleaning. If only two are in use, no lock-out need be feared unless both fail together, which has never been known. None the less, to make the risk more remote, quadruple time locks are supplied. If the 72 hours' period is not considered long enough, there are 96-hour locks and even 120-hour locks which cover the time from the day before Good Friday until the morning of Easter Tuesday.

When a time lock has been wound to open in a certain number of hours, the time cannot be shortened. Thus a dishonest bank official could not set the clock properly to show all right during the day and then immediately, before locking the safe, reset the movements so as to open at some previous hour to suit his convenience.

The dials cannot be set for opening at a certain time and fail through lack of winding the movements. It is only by winding that the time can be set. Furthermore, there is always ample reserve in the main springs, that is to say, the springs do not exhaust themselves in bringing the dials to zero, but could carry the dials farther if it were not for the stops.

Should the safe bolts be thrown while the door is open and after the lock has been set, provision is made for restoring the lock to the proper condition when the safe bolts have been withdrawn by the outside handle.

It is sometimes asked how the owner may open the safe in an emergency before the time is up. The answer is that he cannot. If there were a way, the object of the time lock would be defeated. The thieves could demand the secret of the method under threats. It is better for the owner to suffer a possible occasional and temporary inconvenience for the sake of maximum security at all times.

Less than ten years ago, another kind of time lock or time fastening was patented. Within the apartment to be locked was a vessel containing water or other liquid placed above a second vessel The liquid from the upper vessel was arranged to fall drop by drop into the lower. After a time the lower vessel attained a certain weight and overbalanced a lever. This liberated a weight, which, gathering impetus as it descended, struck a catch and unfastened the door. The inventor put forward this as a device to give animals access to their food at appointed times.

CHAPTER X

WAYSIDE PARAGRAPHS

It has been said that in the thousands of years during which locks have been made, only some four or five really distinct mechanical systems have been devised.

On certain exceptionally massive safes, key locks have to be fitted to comply with the wishes of the customer. There is from 8 to 12 in. of solid steel and anti-blow-pipe material in the door. Consequently, the keys are anything up to 16 in. long. As they are too big to carry, the keys are made with detachable bits. The bow and the stem in one piece are kept on a hook near the safe. The bit remains in the possession of the responsible person, who carries it on his key chain or in a case. The key is so made that bit and stem can easily be connected or disconnected without the use of tools.

Mention has been made elsewhere of a key with an expanding bit, and of one with a removable and adjustable bit. In another pattern the bit was pivoted and lay in the stem until inserted in the lock, which movement forced the bit to project beyond the stem. Two keys hinged together in the stem have been made for folding when in the pocket, the bit of one serving as the bow of the other when in use.

When a lock has a through keyhole so that the key may be used on both sides of the door, it is necessary for the key to be symmetrically formed, which is to say that the bit must be alike on each side of a centre line at right angles to the stem. This reduces the differing possibilities of lever and other kinds of locks compared with the possibilities when the key enters the lock on one side only. Various means have been put forward to obviate this disadvantage. One method is to use a one-side key for a two-side lock, in which case the outside and inside keyholes are not opposite each other. This is done, but not extensively. Although it meets the case, it necessitates a somewhat costly construction.

In order to get the keyhole, in house door locks especially, as far as possible from the front of the lock, some makers reverse the levers, end for end, and put the pivot near the bolt head. If the levers are of considerable length relative to the lift which the key imparts, there is little objection to the custom. With short levers the effect is not so good.

In more than one kind of mortise lock for house doors, the keyholes have been in the knobs. According to one construction, the outer portion of each knob was hinged as a lift-up lid, behind which the keyhole was concealed.

Locks have been made with adjustable keyholes, so that the keyhole distance from the edge of the door might be arranged most conveniently.

A door lock with a chain bolt was introduced a few years ago for ships' cabins. The bolt could be used as an ordinary dead bolt for locking the door in the closed position, or, alternatively, it would rigidly fasten the door a few inches ajar for ventilation purposes. In either case, the key was required for opening.

To resist the action of acids inserted through the keyholes, the use of platinum and gold, pure or alloyed, as well as copper, tin and antimony has been recommended for the internal parts of safe locks.

Escutcheons coated with a luminous paint have been proposed to enable a person to find the keyhole on a dark night. With the same object in view, another inventor fitted in the barrel of the key a small electric lamp and a battery, the switch being a knob in the bow of the key.

The story is told of a lockmaker who, about the year 1812, was put in Stafford Gaol for debt. He picked the locks placed between himself and liberty, and made his escape. Then it occurred to him that, if caught, he might get a further term of imprisonment, so, in the words of the narrator, "he went and picked himself in again."

As far back as 1856, and on numerous occasions more recently, people have come forward with schemes for locking simultaneously, either automatically or from the guard's van, all the carriage doors of a train in motion. The railway companies do not adopt such a device, for very good reasons. To use one lock to secure simultaneously all the drawers in a chest or cabinet is a more reasonable proposition, and has been accomplished in several ways.

Numerous devices have been invented to provide security either by making the keyhole secret or attempting to close it against the introduction of false keys or picklocks. One custom has been to place the keyhole in the carving on the outside of the chest or cabinet, so that it was fairly well concealed. Another method is to have it behind a movable portion of the moulding or other decoration. These devices may have an aesthetic value, but the security gained is very slight. The keyhole can generally be found after a short search, even if frequent use of it has not revealed its position by scratches or discoloration. Of keyhole obstructions, whether in the form of shutters or slides, simple or complex, with or without springs, it may be said that if the proper key can find a way in, so can other things. Nothing short of a lock will serve as a lock. What is more, a lock can be used time and again, and still retain its original security; but a secret or a puzzle contrivance, once discovered, is valueless. To obstruct a keyhole properly, another lock must be used, and for this purpose, escutcheon locks (see Fig. 31) are made. These can be fixed over any existing keyhole, and the fixing screws are covered when the escutcheon lock is locked. Furthermore, this forms a ready means of providing dual control, if one person holds the escutcheon lock key and another has the key of the main lock.

To obstruct from the inside a keyhole which passes right through the door, is another matter altogether. Several good methods are known by which the guest at an hotel, for instance, can prevent a person outside from putting a key into the lock of his bedroom door. Leaving the key in the lock on the inside is not to be recommended, as it may be turned with special pliers by one outside the room.

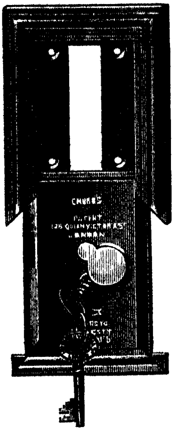


FIG. 31

ESCUTCHEON LOCK FOR COVERING A KEYHOLE

Previous to the reign of James I, there is little or nothing on record concerning the inventions of our forefathers. Before that time there were no patent laws to protect inventors, and as a consequence they kept their ideas as secret as possible so as not to lose the benefit of their ingenuity. On this account, it is difficult to fix the date of particular inventions (relating to locks and keys) and of scientific discoveries of all kinds. As soon as protection was granted to inventors, records of improvements in the arts and sciences abounded.

The first invention ever secured by law to the inventor was for " Engraving and Printing Maps " in 1617. The first patent granted for locks and latches was to George Black in 1774 for " a latch or lock so made as to raise the door over the carpet, and so made as to admit air into the room without opening the door." Since that time to the present there have been rather more than 3,000 British patents in connection with locks and keys.

From	1774–1860	the average was	4	patents annually.
,,	1861–1880	,,	13	,,
,,	1881–1900	,,	52	,,
,,	1901–1920	,,	63	,,

A man once wrote to a lock manufacturer saying that he had noticed how often the keys belonging to the locks on pieces of furniture were missing through being lost or mislaid. Forgetful of the primary object of a key, he said he could, if desired, put forward an idea for the purpose of preventing a key ever becoming separated from the lock which it opened.

To make the way of the key into the lock a tortuous one, requiring several different movements, such as push, turn, push, turn, is an old idea, although still brought forward from time to time as a novelty.

On the Continent of Europe, bright steel left in its natural colour is often used for both the external and internal parts of locks, for which brass would be the English manufacturer's selection. The key guide on the front of cabinet and other locks is commonly fitted in France and Germany.

If the opening of a lock causes an electric current to be made so that an alarm sounds or another signal is given, there is no more objection to the device than there is to the ringing of a bell when a shop door is opened. In such a case, the lock may perform the usual functions and operate mechanically. There have been locks invented to open electrically without a key. The drawback to such contrivances is that generally it is so easy for unauthorized persons to interfere with the system and put it out of order, if not undo the lock. In the matter of cost, the balance usually turns in favour of the lock operated by a key. There are the same objections to locks pneumatically controlled.

Not many years ago there was periodic demand for locks with twenty-four levers. These locks, which measured nearly 2 in. thick, required exceptional care in the making, and were beyond the ability of all but the best locksmiths.

In some qualities no attempt is made to differ as many locks as possible, as to do so would increase the cost. The makers frequently content themselves with differing as few as six or twelve, and then repeat. This is the practice with certain types of house door locks, as well as with smaller kinds.

A simple lock like a back-spring lock can be made of no more than five pieces: the plate, the bolt, a spring to hold the bolt out or in, the cap, and the key. The number of pieces is only four, if the bolt is made from one piece of metal formed to serve the double purpose of bolt and check spring. At the other end of the scale there is produced by a French firm a modern safe deposit lock, opened by a permutation and two keys, which contains over 150 pieces.

The bolt stump is perhaps the weakest spot in a lever lock, although if made from one piece of metal in the form of two uprights and a cross bar, one upright being close against or recessed into the bolt head, the criticism falls to the ground. Locks have been made without a bolt stump, the levers being without racks or gatings. A slot or gating was formed in the bolt head, and the solid ends of the levers, if lifted to the proper height, fitted this slot on the indrawing of the bolt. In another arrangement, the stump was not in the bolt, but rigidly fixed between plate and cap. The levers were pivoted on the bolt and travelled with it. This method made the lever stump the weak member, since its top was not supported in the cap, as in the best practice it is.

The Singapore agent of a Willenhall firm, writing to his principals in 1865, said it was amusing to see how the Chinese out there fastened some of their doors. A single Chubb padlock would be considered sufficient; but if common locks were used, the door would frequently be fitted with two hasps, and in each hasp as many as three padlocks.

As a general rule, a lock should not be oiled. If it gets stiff or fails to perform, it probably requires cleaning. Oil is only a temporary remedy, and collects more dirt. One who was not imbued with this doctrine conceived the idea of lubricating the latch bolt copiously through a hole provided for the purpose, and conveying the oil thence by a pipe and channel to the tumblers and dead bolt below, after which any surplus was to be absorbed by a sponge inside the lock.

Stating that the fingers of different persons varied in length, an inventor designed a lock to be opened only by the insertion of fingers of certain lengths. In another invention, according to the claim, the lock and key were made to correspond with the owner's finger prints.

Some of the imaginative writers have strange ideas about locks. In their works, one may find a passage like the following: "The hero, supporting the fainting heroine on one arm, stood with his back to the locked door through which was the only hope of escape, and faced his pursuers. With his free hand he drew from a secret pocket a delicate instrument made of the finest steel. This he placed in the keyhole behind him, and with a quick movement the intricate mechanism of the lock was set at nought, and the way to safety lay open." As to this it may be said that there is not such a thing as a universal lock pick. The instrument or instruments used must be suitable for the kind of lock attempted; and a person without knowledge of the construction of the lock, even if it is one of the commoner varieties, might take some time to open it. If skeleton keys are used, a fairly large assortment is needed for the different sorts and sizes of warded locks.

One of the objects of interest at the Great Exhibition of 1851 was "Aubin's Lock Trophy." This was about 30 in. high, consisting of a central column carrying several tables or platforms at different heights. On these were faithful representations, beautifully made and ornamented, of forty-four different lock movements by the most celebrated inventors. Mr. Aubin, the artificer, was himself a lockmaker of no mean fame. The turning of the key of the lock at the top of the column caused the simultaneous movement of the bolts of all the locks below, with the exception of six, which were mounted vertically on the base. The trophy is now in the possession of Messrs. Hobbs, Hart & Co., London.

Different inventors at different times have designed locks to injure if not to kill those who made unlawful attempts to open them. One appeared in 1840. In this, near the lower end of the keyhole, was mounted a tube containing a metal dart or sharp-edged punch, behind which was a spring under compression. The overlifting of one of the levers, which was almost bound to occur if anything but the proper key was used, released the spring, which shot the punch through the keyhole, wounding the hand of the offender. The face of the punch, being in the form of a letter or figure, inflicted a wound which for several days identified the individual, for which reason these locks were called identifying detector locks. Another lock was planned to discharge noxious powders. In 1905 was patented a lock to explode a bomb on the introduction of a false key. Another variety proposed, although the method was not explained, was one to catch in the act, but not to injure the person making the attempt.

Cabinet locks, with lever mechanism and flat keys, are often made with hollow brass nozzles on the front to pass through the door. The nozzle serves a twofold purpose: it provides a cavity for the orbit of the key stem as well as for the barrel which forms both key guide and bearing, and it fills what would otherwise be a large and ugly keyhole in the door. A key with a cylindrical stem takes its bearing in the plate and cap of a lock like an ordinary spindle running in journals, and its bit, having passed through a slot to the inside of the lock, needs no space for its orbit outside the body of the lock. A flat key, having a stem considerably wider than thick, would not work satisfactorily if rotating without other support in round holes, and for this reason a rotating barrel, which the key fits, is provided. When the axis of rotation of a flat key is not its centre line, but, as frequently, near one edge, the space required for its rotation is a cylindrical cavity, which in diameter is almost twice the width of the key stem. This would necessitate a round hole in the door as large as the nozzle if the nozzle was not provided.

CHAPTER XI

THE INDUSTRY

WOLVERHAMPTON, Willenhall, and neighbouring places, all lying within a few square miles in South Staffordshire, form together the chief lockmaking district in this country. In London, Birmingham, and other places outside that area, there are a few factories of importance. It is not known when the manufacture of locks in Wolverhampton and district began, but for several centuries it was the staple trade. In the sixteenth century it was an industry of great importance. According to trustworthy old records, there were, as early as the reign of Queen Elizabeth, " ingenious craftsmen in Willenhall well skilled in the making of locks and keys." In the seventeenth century, lockmaking was the principal, if not the only, trade of Wolverhampton. Dr. Plot, writing in 1686, says: " The greatest excellency of the blacksmiths' profession in this country lies in their making of locks for doors, wherein the artisans of Wolverhampton seem to be preferred to all others." One authority considers it possible that the superior quality of the iron of the district attracted locksmiths to it.

A Portuguese merchant, writing an account of his travels, about the year 1732, says with reference to Wolverhampton: " The chief manufacturers of this town are locksmiths, who are reckoned the most expert of that trade in England. They are so curious in this art, that they can contrive a lock so that if a servant be sent into the closet with the master-key, or their own, it will show how many times that servant hath gone in at any time, and how many times the lock had been shot for a whole year; some of them being made to discover five hundred or a thousand times. We are informed also that a very fine lock was made in this town, sold for £20, which had a set of chimes in it that would go at any hour the owner should think fit."

In 1770 the parish of Wolverhampton, which then included Bilston and Willenhall, contained 290 locksmiths. By 1855 the number of master locksmiths in business in the district was 452, but most of them were in a small way, employing only a few workpeople each. These figures are taken from Mr. G. Price's book *On Locks and Keys.* In 1867 the number of employers in Willenhall alone was estimated at 275, and the number of workpeople at 3,000.

In the early times the locksmith worked in his own small smithy, which often formed a portion of his dwelling-house, and had no assistance beyond that which the members of his own family gave. The japanning of the locks, when japanning began, was the work of his wife, who dried or baked them in the kitchen oven. The children, even those quite small, were engaged in some process of the work. As the locks were completed, they were laid on the kitchen shelf to await the arrival of the packman, who paid periodical visits to the place, and, no doubt, made shrewd bargains for its wares.

The reason for there being at one time such a large number of employers, in a very small way of business, is attributed by one chronicler in the middle of the last century to the apprenticeship system. This, so the writer states, was carried on to a remarkable extent in Willenhall, the small masters taking apprentices at any age at which they could work. Most of these boys came from other towns. They brought a small fee and were legally bound for a certain time. Some masters employed only apprentices. On the expiration of his term of apprenticeship, the young man was almost compelled to start himself as a small employer, when his master would not retain him and he could not get an engagement under another.

From the word "locksmith" itself, apart from other references, it will be understood that lockmaking at one period, and that a considerable period, was a branch of the blacksmith's art. The only materials available in those days were black iron bars in a few sizes. As sheets or strips were not procurable, the lockplates had to be hammered out on the anvil from bars heated in the smithy fire These plates were then cut to shape with shears and chisel. Padlock shackles were forged from square bars or rods, and most of the keys, if not all, were hammer forged. It is recorded that one manufacturer more than a century ago bought old horseshoes from which he made the internal parts of his locks.

The fly press, which appeared about 1790, and was utilized for shaping and piercing lock plates, was of great service to the trade. Soon afterwards, another innovation that marked an important advance was the process of stamping or drop forging. Key blanks produced by this method were obtained from Birmingham in 1806; and then, in 1810, at Compton, a village near Wolverhampton, a maker, whose business has continued until the present day, began to supply key stampings, which, it is said, excelled all others a century ago. Malleable iron castings for locks appear to have been in use for some years before 1816, when keys made by this process were introduced.

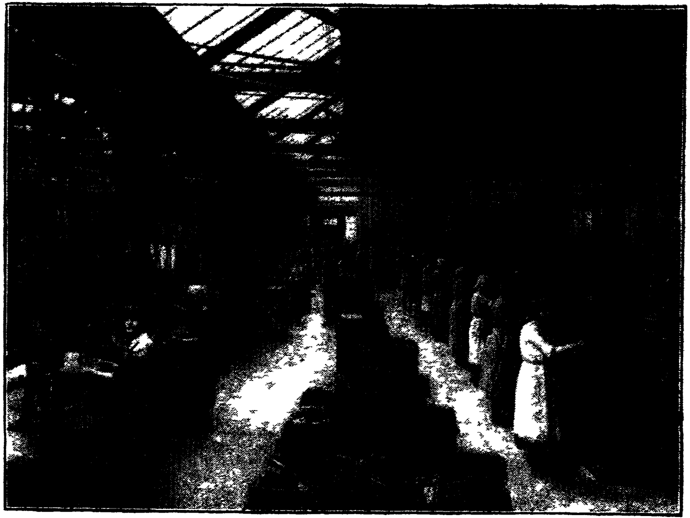
Even when the locksmith's raw materials included brass castings and rolled flat strips in iron and brass, whereby much work at the forge was saved, he was poorly served compared with the present day. In addition to all that there used to be, there are now extruded bars of almost any section in brass and other non-ferrous alloys, drawn brass not only in light angles and channels suitable for the plates and caps of locks, but also in other and heavier sections. The lockmaker may have die castings in brass and aluminium bronze, if zinc and aluminium alloys are not hard enough. Alternatively there are hot brass stampings or brass drop forgings, which can be made in intricate shapes and very closely to required size. Nickel silver, from which great numbers of flat keys are made, is a most useful material. Rustless steel is already adopted and almost certainly will be more extensively employed when it gets cheaper. The list could be lengthened. Not least worthy of remark is the benefit obtained by the lockmaker by reason of the superior products of the steel works. No longer must he be content with bars and strips of rough black surface and uncertain dimensions. Smooth material, black or bright, soft or hard, rolled or drawn, almost dead to size required, is at the locksmith's service.

Cast iron is altogether unsuitable for any part of some locks, but is quite satisfactory for the cases and other portions of certain patterns. In the early sixties of the last century, locks with cast-iron cases were being made by at least one manufacturer in Willenhall. Whether or not this was before the Americans used cast iron for locks cannot be stated. This much, however, is known. A generation or so ago the cast-iron lock parts from the United States' foundries surpassed the British, the shape being so well defined and the surface remarkably smooth. If the state of things is not now reversed, it may be said that the best exponents of the art in Willenhall consider that they have made good.

Although a few small workshops remain, an increasing number of large, well-planned and equipped factories is the present state of affairs in the lockmaking district. Lockmaking to-day is not a branch of the blacksmith's profession, but a branch of engineering, combined in some instances with the art of clockmaking. In a modern factory will be found a large assortment of the engineer's machine tools, such as centre and capstan lathes ; shaping, milling, grinding, drilling, and tapping machines ; in addition to massive and lighter power presses, riveters, etc. In the finishing department, besides polishing and lapping spindles, is plant for japanning, plating, bronzing, oxydizing, etc., in various styles. Not only the engineer's tools, but his methods, are adopted, jigs of all sorts, micrometers, limit and other gauges, being in constant use.

Perhaps the most serviceable of all machines n the lock trade is the power press. Even a single-acting press for forming a flat blank from sheet metal and putting the holes in is a boon. With a more elaborate design, however, not only are such operations as drawing, flanging, bending, and embossing more readily done, but several operations can be performed at one stroke, and the finished case of a lock is produced in a few seconds. The press toolmaker is a valuable assistant to the lock manufacturer.

The terms hand-made and machine-made, as applied to locks to-day, are not very exact, but have to serve in the absence of something better. In a so-called hand-made lock it is almost a certainty that some machine-turned parts, like stumps, screws, and key blanks, will be used, if not pressings from a machine, and also, it may be, other machined components. The



By courtesy of *Messrs Josiah Parkes & Sons Ltd*

FIG 32

DRILLING MACHINE BAY IN A WILLENHALL LOCK FACTORY locksmith, while he proceeds with the making of the lock, may require the help of a drilling machine and perhaps a lathe. In a so-called machine-made lock it may be necessary for some fitting or adjustment to be done by hand, in addition to assembling the parts and screwing up the case. Certain locks, from the nature of their construction, like the pin tumbler lock, would be most difficult if not impossible to make, unless a considerable amount of machining was done. So insignificant or non-existent are the exceptions, that it is true to say that both machine and hand work enter into all locks. "Where one ends the other begins," may determine the description applying to the making of the article.

Some works which are organized only for certain lines of production will not accept orders for anything else. Others have a department where all sorts of special locks can be made to particulars given, however small the number required. It is not an infrequent occurrence for the purchaser of a piece of furniture or a suit-case, when not satisfied with the locks fitted, to have them all replaced by others of superior quality made exactly to the same outside size and shape. Sometimes the cases of the original locks are used again, new works being mounted inside. Such locks are necessarily hand-made from the most suitable materials in stock, if the number does not justify the ordering of special supplies. On the other hand, for locks made all alike in large quantities, it is not surprising in this mechanical age to find that as much work as possible is done on machines.

The number of varieties in locks will surprise many people. The catalogue of one lock-making company in Staffordshire shows 1,260 varieties, when pattern, size, and quality are taken into account. Many of these can be supplied in several finishes, which further adds to the number. A large corporation in the United States lists more than 480 different kinds of door locks only, many of which have to be made both left and right hands. In a German firm's catalogue of padlocks are over 330 varieties, not including the several finishes in which most kinds can be supplied. In establishments where many sorts and sizes are made, the stock of materials and component parts in various stages is sometimes very large, and this in addition to the stock of finished locks.

Modern locks may be said to be characteristically British, American, or German in style. Each style has gained acceptance in one place if not another, so that the markets of the world may be broadly divided into three groups, designated according to the patterns favoured. This is not to say that locks of only one country of origin find a sale in any one market, but it is notorious that some countries which have long been buying from one source will not favourably consider the products of another even if they possess undeniable advantages. These customs or prejudices have to be recognized and taken into account as much as the opposing tariffs, which prohibit any great volume of British sales in the United States of America, France, Germany, and other countries.

The effect of foreign competition has been felt in this country for many years, and still is felt. Import duties are not imposed on locks arriving from abroad. While foreign competition reduces sales at home, it has also a beneficial result. Some forty-five years ago an outcry was raised because a London merchant obtained locks from America for a building only a mile or two from the centre of the lockmaking district in Staffordshire. Naturally those in the trade locally were aggrieved, but the incident stirred them to efforts to prevent the happening of such a thing again, with the result that the industry gained a much stronger position than previously. Willenhall can point to the instance of a firm in that town which struggled hard and long against the well-known products of an overseas competitor, until assiduous effort was rewarded. At the present time the padlock trade is seriously affected by imports, chiefly of the cheaper varieties, from Germany. Much as this loss of business is to be deplored, it has to be admitted that wonderful value for the money is given in these articles by the Germans. History may repeat itself if the challenge is accepted, so that the foreign competitor in these products may find himself beaten after a time. While considering the effects upon the lock trade at home of actions by foreign governments and manufacturers, it is interesting to read a statement by Mr. J. C. Tildesley in 1865. In an article appearing in a volume entitled *The Resources, Products, and Industrial History of Birmingham and the Midland Hardware District*, Mr. Tildesley, who was a lock manufacturer in Willenhall, wrote "Thirty years ago the United States was by far the most extensive market the lock trade had—indeed it was estimated that at one time more than half of the locks made in this district were sent there. Now, however, as for some years past, the States do not buy any but till and pad locks; and even these are gradually being made in their own market."

The industry in this country, although not a large one by the side of many others, has its accredited organizations. The employers' interests are watched by the Lock and Latch Manufacturers' Association, and those of the workpeople by the National Union of Lock and Metal Workers. Representatives in equal numbers from both bodies form a Joint Industrial Council to deal with important questions connected with the trade.

As a result of the labours of these organizations, conditions have been much improved and the prestige of the industry increased. One of their achievements within the last few years has been the grading of locksmiths according to their work. As locks can be bought for a penny or two, while at the other extreme there are those costing several pounds each, it is clear that the work admits of classification, and that some locksmiths require a higher degree of skill than others. The system adopted has been to divide the work into four classes, and the men into four grades in each class, with a minimum rate of pay against each of the sixteen ranks. By another resolution to encourage up-to-date methods in the factories, which the Workers' Union declares are to the advantage of the trade and therefore of the locksmiths, piecework prices are fixed according to the pattern of lock and the condition of manufacture. That is to say, if in two factories there are being made locks of exactly the same kind, the making price per lock will not necessarily be the same in each place: if one is better organized and equipped than the other, that factory will pay to the locksmiths a lower price per lock.

In 1926 careful records showed the number of lock factories, large and small, in Great Britain to be—

Wolverhampton	22
Willenhall and neighbourhood	95
Elsewhere	23
	140

In those factories were employed—

Skilled locksmiths	2,393
Apprentices and youths	450
Women and girls	1,529
Toolmakers, machinists, and charge hands	200
	4,572

By adding those employed in the foundries, together with labourers and others not already included, the total number of workpeople engaged in lock making at that time would be 5,000 approximately.

Several important British companies engaged in lock making are manufacturers of safes also, and the latest returns from the Board of Trade couple these two industries. According to the Census of Production for 1924, the firms that were mainly concerned in the manufacture of locks and safes employed 7,388 persons.

The industry finds employment for more than those who work in the lock factories. There are separate businesses to supply castings, stampings, etc , of which much of the output is used in the lock trade.

Of the extent of employment in the trade outside these islands, comprehensive figures cannot be given. It must suffice to say that the number of operatives employed by one important corporation in the United States, whose manufactures are chiefly locks, but include other commodities has been given as about 6,000.

The value of the locks, latches, and keys made by the lock and safe making companies was given as £1,190,000 in the 1924 Census of Production. In addition, locks, latches, and keys valued at £127,000 were made by other firms, raising the total production in the year to £1,317,000.

The number of locks made annually in this country has been estimated by more than one authority at 12,000,000 approximately.

[*Note to the Second Edition.* To bring the preceding figures up to date at the time of writing in 1931 would make serious reductions, on account of the prevailing world-wide trade depression, which has affected this industry with others. Such a state of things, it is hoped, is only temporary.]

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